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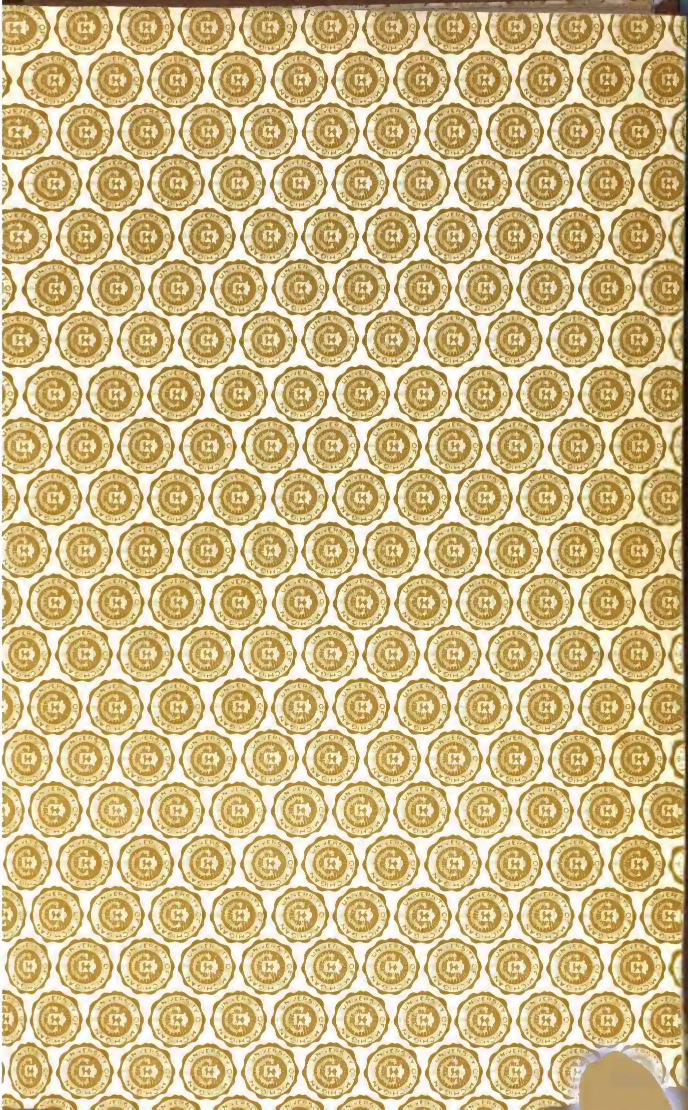

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MEMOIRS
OF THE
GEOLOGICAL SURVEY OF INDIA.

India. Geological Survey.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL,
UNDER THE DIRECTION OF
THOMAS OLDHAM, LL.D.,
Fellow of the Royal and Geological Societies of London; Member of the Royal Irish Academy; Hon. Mem. of Leop-Carolino Academy of Natural Sciences; of the Isis, Dresden; of the Roy. Geol. Soc., Cornwall; Corr. Mem., Zool. Soc., London, &c., &c.,
SUPERINTENDENT OF THE GEOLOGICAL SURVEY OF INDIA.

CRETACEOUS FAUNA OF SOUTHERN INDIA.

Vol. IV.

The Brachiopoda, Ciliopoda, Echinodermata, Anthozoa, Spongiozoa, Foraminifera, Arthrozoa and Spondylozoa,
by Ferd. STOLICZKA, Ph. D., F. G. S., &c., &c.,
Palæontologist, Geological Survey of India.

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INTRODUCTION.

Ten years have elapsed since the commencement of the present series of Monographs of the fossils which had been collected in the cretaceous deposits of South India during a geological survey of the Trichinopoly and South Arcot districts. The series was commenced in 1862 by Mr. H. F. Blanford—under whose superintendence nearly all the fossils had been collected—by the description of the *Belemnites* and *Nautili*. At the end of 1862 I took charge of the continuation of this series, and since then its publication has progressed without interruption, and with such little delay as the funds available for this object have permitted. To each of the classes of Mollusca, the *Cephalopoda*, *Gastropoda*, and *Pelecypoda*, or Bivalves, one separate volume has been devoted. The first volume was completed in 1865, the second in 1868, the third in 1871. The present fourth volume, which is devoted to the remaining portion of the invertebrata, and a few vertebrata, commenced in 1872, and will, it is to be hoped, leave the printer's hands by the end of April 1873.

Reverting this order according to a more natural arrangement, we find that the different groups of animals are represented by the following numbers of species, most of which have been found sufficiently well preserved to be characterised and figured:—

I.—*Foraminifera*, with a single well defined species, *Orbitoides Faujasi*, Defr., and two doubtful ones.
II.—*Spongiozoa*, with one species, *Siphonia pyriformis*, Goldf.
III.—*Corals*, with 57 species.
IV.—*Echinodermata* (including *Asterioidea* and *Crinoidea*) with 42 species.
V.—*Ciliopoda* (or *Bryozoa*, or *Polyzoa*) with 23 species.
VI.—*Brachiopoda*, with 21 species.
VII.—*Pelecypoda*, with 243 species.
VIII.—*Gastropoda*, with 237 species.
IX.—*Cephalopoda*,* with 146 species.

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* Comp. my additional remarks on this class in Records Geol. Surv. India, vol. I, 1868, pp. 32 to 37.

X.—*Vermes*, with 5 species.

XI.—*Crustacea*, with 3 species, all specifically undeterminable.

XII.—*Pisces*, with 17 species, only characterised by solitary teeth.

XIII.—*Sauria*, bones and a tooth, apparently belonging to a *Megalosaurus*.

Thus, nearly seven hundred and eighty species of animals have been noticed in this series of volumes, devoted exclusively to the description of the fossil remains found in the cretaceous beds of the Trichinopoly and South Arcot districts.

At the conclusion of each of the different Monographs, I have given a short review of the geological facts bearing upon the study of the respective class, and this dispenses with the necessity of going into detail on this occasion.

I may briefly notice the following:—

Mr. H. F. Blanford, assisted by several colleagues in his survey of the Trichinopoly and neighbouring districts during 1858-60, arrived at the conclusion that the cretaceous deposits* are divisible into three groups, the lowest the Ootatoor-the next the Trichinopoly-, the highest the Arrialoor- group.

This division has been retained throughout all the Monographs, and I am glad to say, it has been very much strengthened by the examination of the fossils, many of which are peculiarly characteristic for the respective groups. The general results of this examination can be very briefly expressed in the following table:—

South India.		England.	France.	Germany.
Ootatoor Group ..	Zone of *Amm. rostratus* and *Rotomagensis*, *Inoceramus labiatus*, *Gryphæa suborbiculata* (=*columba*) and *Terebratula depressa*.	Upper Greensand and Chalk Marl.	Cenomanien or Tourtia	Unter Quader (Unterer Quadersandstein and Unterer Pläner).
Trichinopoly Group ..	Zone of *Ammonites peramplus*, *Pholadomya caudata*, *Modiola typica*, *Gryphæa diluviana*, *Rhynchonella compressa*.	Lower Chalk ..	Turonien	Mittel Quader.
Arrialoor Group ..	Zone of *Nautilus danicus* and *Amm. Ootacodensis*, *Exogyra pectinata* and *angulata*, *Gryphæa vesiculosa*, *Inoceramus Cripsii*, *Crania Ignabergensis*.	Upper Chalk ..	Senonien	Ober Quader.

The parallel is of course only general, but considering the great distance of these deposits, it is as close as could be expected. If we would enter into details, the deposits, geographically so differently situated, would no doubt show some peculiarities of their own, and an absolute identity of the succession of the beds might not be possible, partly because some of the species had, on account of physical peculiarities, a greater or lesser range in one locality than in the other, partly because the succession of the beds had been studied with greater exactitude in one than in the other place. The former case may be illustrated, for instance, by the occurrence of *Inoceramus labiatus* in the Ootatoor group, while both in France and in Germany the beds with this species are considered as the lowest of the Turonien, or Mittel Quader, of which Geinitz says that it is the most characteristic fossil. Again, *Gryphæa diluviana* and *carinata* and *Rhynch. compressa* are stated by Geinitz to occur in the upper horizon of the Lower Quader, while in South India they are referable to the Trichinopoly group. However, we must not absolutely rely upon these facts as strictly correct, for Mr. Blanford himself repeatedly says that the boundaries between the different groups could not in all cases be so carefully ascertained as might be desired; and besides, a strict classification of the beds according to palæontological zones could hardly be expected to have been thoroughly carried out at the time of Mr. Blanford's survey.

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* Resting on plant-beds of apparently uppermost jurassic age, and these again immediately on gneissose rocks.

This must be the task of a subsequent revision of the geological ground, on the combined basis of the stratigraphical and palæontological information which we have obtained.

In dealing with this subject one fact must not be overlooked. When describing the Cephalopoda, (setting aside the two or three Gastropoda and Pelecypoda), I have noticed from the Ootatoor group a comparatively small number of species which are, never known to occur in the Cenomanien beds of Europe; I refer to such characteristically Neocomien species, as *Nautilus Neocomiensis* and *pseudo-elegans*, *Ammonites Velledæ* and *Rouyanus*, or to such Gault forms as *Nautilus Bouchardianus* and *Clementinus*, *Ammonites Timotheanus* and *latidorsatus*, *Turrilites Bergeri*, *Gressleyi* and *tuberculatus*, etc. Some of these and other identified species might possibly be shown to be distinct, if really perfect materials were obtained, but others scarcely leave any doubt as to their correct determination. It is expected that subsequent researches will show whether the beds containing these older species can be in any way stratigraphically separated, or whether the species themselves possessed in India a higher range in geological time.

Prof. Forbes when examining the Pondicherry fossils, the greater number of which were from the lower (Valudayur) beds at that locality, pronounced these beds to correspond with Neocomien or Lower Greensand. His argument was less based upon specific identifications than upon the general character of the fossils, as, for instance, the numerous *Anysoceras* (*Ancyloceras* auctorum) and *Hamites*.

Most of these species have been unquestionably shewn to occur in the same beds with *Am. rostratus*, and his conclusions lose, therefore, very much of the value which they otherwise would have possessed. Again, the Trichinopoly fossils, most of which appear to have been from the neighbourhood of Serdamungalum, Prof. Forbes regarded in general character as Upper Greensand and partly as Gault. These beds are undoubtedly younger, having been in the present Memoirs referred to the Trichinopoly group, and relatively Forbes' parallel was, therefore, correct, but not strictly according to the age. D'Orbigny's fossils, collected by Mr. Fontanier, appear to have been chiefly obtained from the higher (Arrialoor) beds at Pondicherry, and were readily pronounced by that celebrated Palæontologist as characterising the upper cretaceous beds. At first he thought the majority were Turonien species, but shortly after he corrected himself and referred the whole of them to the Senonien.

Date of issue of the different parts of Vol. IV.

No. 1.	THE BRACHIOPODA,	pp. ii, 32, & 7 plates,	were issued	6th Nov. 1872.
No. 2.	THE CILIOPODA,	pp. ii, 34, & 3 plates,	„	18th Jan. 1873.
No. 3.	THE ECHINODERMATA,	pp. ii, 59, & 7 plates,	„	25th April 1873.
No. 4–5.	THE CORALS, SPONGES, &c.,	pp, ii, 70, & 12 plates,	„	10th May 1873.

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INTRODUCTION.

The Brachiopoda in the cretaceous deposits of the Trichinopoly and South Arcot districts of Southern India are not nearly so numerous as are the three other classes of Mollusca—Cephalopoda, Gastropoda, and Pelecypoda—which have been dealt with in the previous volumes of the *Palæontologia Indica*. This smaller number of species might have been naturally expected, for although the Brachiopoda often abound in the number of specimens in the younger mesozoic strata, the number of generic and specific forms does not more than approach that of the other classes of Mollusca.

Regarding the classification of the Brachiopoda and their allies,* in several important anatomical points, as well as regarding the system of nomenclature and other similar details, I have already spoken in my introductory notices to the other classes of the Mollusca, and it will, therefore, not be requisite to repeat those statements in this place. Neither will it be necessary in the examination of the South Indian cretaceous Brachiopoda to enter into those details of general classification which it has been deemed advisable to place on record, when working out the three other classes of Mollusca. The comparatively early publication of such a splendid handbook as that on the "Classification of Brachiopoda" by **Thomas Davidson**, Esq., and the translations of the work into French by **Deslongchamps**, and into German by Prof. **Suess**, fully account for this. We have also an excellent account of this class by **Bronn** in his "Klassen und Ordnungen des Thierreiches," and several authors have added to our knowledge of it since the publication of the last named work.

A third point to which I paid particular attention in the other classes of the Mollusca was to give, as far as possible, a complete list of the species of each class, as represented in cretaceous deposits in general. This important resumé had been initiated by **Pictet** in his famous "Materiaux pour la Paléontologie Suisse." And as the lists of the cretaceous species of the three preceding classes of Mollusca had been already completed, or very nearly so, and only required some additions, I had a reason for endeavouring to supply the latter. However, as this is not the case with the critical lists of the Brachiopoda, which are probably at the present time in preparation, I have not the same object in view as I had before. Besides, we may fairly expect that Prof. Pictet's accounts, with the larger materials at his disposal, will be far more complete than anything I could supply.

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* Saccopoda or Tunicata, and Ciliopoda or Bryozoa.

In this way my work will be limited to giving detailed descriptions and figures of those species which occur in our South Indian cretaceous deposits, and I shall only briefly preface these descriptions by a short statement of the organisation of the class, and of the families and genera to which the Indian species are referable.

A brief summary of the geological results will be given in a separate article at the end of this paper.

Calcutta, May 1872. F. STOLICZKA.

BRACHIOPODA

OF THE

CRETACEOUS ROCKS OF SOUTHERN INDIA.

Sub-kingdom, MOLLUSCA.

Class, BRACHIOPODA, *Cuvier.*

CHARACTER.—*Acephalous Mollusca with the mantle divided into a dorsal and ventral half, each provided at the margin with horny or chitinous setæ; body small, symmetrical, or very nearly so; mouth anterior, nearly central, at the base between a pair of fleshy, internally sulcated and ciliated, more or less spirally twisted arms, which chiefly serve the purpose of branchiæ, and are often supported by solid calcareous processes.*

The two mantle lobes secrete a bivalved, inequivalved, generally symmetrical shell, the two valves being sometimes joined to each other by a pair of hinge-teeth, but they are always kept together by adductor muscles, and are opened by cardinal muscles; the calcareous brachial apparatus, if present, is always attached to the smaller, or hæmal valve, while the larger or neural one is sometimes partially or entirely grown to other objects, and more generally provided with a perforated umbo, through which a fleshy peduncle is protruded, serving for temporary or permanent attachment of the animals. All species are marine.

The history and organisation of the Brachiopoda—or Brachionacephala, as Bronn suggested to call them—have been exhaustively treated by Davidson and Bronn in their works already alluded to. I shall only refer to a few of the more important anatomical and structural points, as explanatory of the above diagnosis.

As regards their external covering—the shell—the Brachiopoda offer several points of resemblance to the Pelecypoda, but they essentially differ from them in the arrangement of the internal organs, and in this respect are more closely allied to the Saccopoda, and the arm-bearing division of the Ciliopoda.

The body is very small, lying at the base between the two almost entirely separated and unequal portions of the mantle, which are dorso-ventrally situated respecting each other, while in the Pelecypoda the two halves enclose the body laterally. Each half of the mantle consists of several layers, the outer of which secretes at its margin the shell. This latter is very variable in structure; very commonly it is porous and punctated, or fibrous and externally foliaceous. The former structure may be said to be typified by the family *TEREBRATULIDÆ*, and the latter by the *RHYNCHONELLIDÆ*. The structural characters of the shell in different families have been elaborately treated by Prof. Carpenter in his paper on the intimate structure of the shell of Brachiopoda, included in the introductory part of the first volume of Mr. Davidson's "Monograph of British fossil Brachiopoda."

The inner layer of the mantle is very soft, and partly of reticulated structure. Towards the margins the two layers are generally more or less intimately connected, and provided on the inner side with long chitinous or horny setæ. Between the two layers is a network of a highly developed vascular system, which is not for the purpose of respiration, as usually supposed, though it may assist in it. However, it is certain that it stands in intimate connection with the development of the ova; it leaves often strong impressions on the inner sides of the valves.

The mouth is situated nearly centrally and at the anterior end of the body between the arms, being at their base often connected by a kind of velum. The alimentary canal is turned neurally, and is of varied length, rarely of the same thickness; usually at a short distance from the mouth it is enlarged into a kind of stomach; it terminates either blindly or with a small opening behind the adductor muscle, and near the hinge-plate of the dorsal valve, either centrally or laterally.

The liver is usually largely developed, consisting of numerous greenish blind sacs, as in other more highly organised Mollusca; it envelopes the greater part of the alimentary canal from the mouth to its end.

The centre of the circulation is a heart, lying free in the cavity of the body above the stomach. It receives a strong vein anteriorly, and sends off two principal aorta branches, one to the mantle and the genital organs, and the other to the digestive organs and the peduncle.

The usually spirally twisted arms, must be looked upon as true respiratory organs, although they besides appear to perform the function of supplying food to the mouth by producing a strong current of water. For this purpose they possess in the middle of the internal side a deep groove, and laterally one or more series of very fine and long fillets. The mantle, which is usually regarded as the organ of respiration, does not perform this function, though it may assist in supplying a change in the water, but it does not possess the necessary vessels to convey the blood to the heart.

All or most of the recent Brachiopoda that have been examined appear to be hermaphrodites. The nervous system has its centre in a complete ring surrounding the œsophagus, and sending off branches to all parts of the body.

As to the muscular system I need not specially mention the various thin muscles and muscular bands which are required for keeping the digestive and other organs in their proper relative positions, and which are necessary for their functions. Only four sets of muscles are of general importance; 1st, the *adductor*, which is the strongest, and has the function of keeping the valves closed; it is dorsally divided into four branches, producing two anterior, larger and stronger, and two posterior, smaller and weaker, scars; ventrally it is nearly united, producing an elongately ovate scar, sometimes divided by a slight median swelling of the shell or by a distinct rib. The 2nd are the *cardinal muscles*, of which there is an anterior and a posterior (or accessory) pair. The first is attached near the umbo of the hæmal valve, and on either of the anterior sides of the adductor scar in the neural valve. This cardinal muscle, usually also called *divaricator*, has as its principal object the opening of the valves. The so-called *divaricator accessorius* is also attached on the hinge plate of the hæmal, and posteriorly on the neural, valve; it is much thinner than the former. The 3rd set are the so-called *adjustatores*, which are intimately connected with the 4th large muscle, or the peduncle; the *adjustatores* are chiefly intended as erectors or retractors of the peduncle, and are, therefore, obsolete or nearly so in those species which do not possess the latter.

A very current idea exists, that the Brachiopods fix themselves permanently by their peduncular muscle to sub-marine objects, but this is, I think, highly improbable. From what I saw of recent *Lingulæ*, I am inclined to believe that they are capable of changing their place actually by the movements of the peduncle, and probably they also swim through the water by opening and closing their valves. I found *Lingula anatina* on the Arrakan Coast a little below tide-mark, and many other *Terebratulæ*, *Orbiculæ*, and others, are known to live in similar places; the majority of the large recent forms indeed are probably littoral, but some also occur at considerable depth, and others only in deep water.

There can not be, I think, much doubt as to the true molluscous character of the Brachiopoda, and their proper classification between the *Anomiidæ* of the Pelecypoda, the Saccopoda, and the arm-bearing section of the Ciliopoda. Mr. Morse's rather startling idea that all the Brachiopoda and Ciliopoda should be classed with the Annelids, instead of forming the lower division of the Mollusca, is, therefore, not likely to obtain much valid support. Its bearings upon classification have been lately ably discussed by Mr. Dall in Am. Journ. of Conchology, vol. vi, pp. 88, &c.* I quite agree with that author's conclusions, that Mr. Morse has come to his conclusions on inadequate grounds. It would not be difficult to point out more characters, than Mr. Dall has noticed, which speak in favor of the now generally adopted idea of the classification of the Brachiopoda. Indeed it seems to me that the differences between the internal organs of the Pelecypods and of the Brachiopods are not so enormously great, as is generally supposed. The division of the mantle is no doubt essentially different, being lateral in the former and dorso-ventral in the latter, and according to this of course all the other organs change. The arms must be looked upon morphologically as the homologues of the labial palpes, but in the Brachiopods they also receive the function of respiration, the true branchia have become entirely obsolete. The adductors correspond to the same muscles of the Pelecypods, the divaricators replace the inner ligament or cartilage, and the adjustators are simply a modification of the pedal muscles, and the peduncle itself is, strictly speaking, only a modified foot turned backwards; all these organs have quite similar structure and functions in the two classes. The nervous ring at the œsophagus is similarly placed in both classes, and the alimentary canal terminates similarly behind the posterior part of the adductor.

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* And again in Am. Jour. Conch., vol. vii, p. 39 *et seq.*

The enormous development of the mantle lobes as compared with the small size of the body may appear abnormal in the Brachiopoda, but we find it of exactly similar proportions, for instance, in *Modiola*, *Pinna*, *Placuna*, and several other Pelecypods.

I have very little doubt that when the anatomy of the *Anomiidæ* and many Brachiopoda are better studied, they will show still more points of resemblance than are generally known at present.

The Brachiopods have been divided into two large groups, the *PLEUROPYGIA* and the *APYGIA*. The former have the valves not joined to each other by any kind of hinge-teeth or folded margin; they have no internal solid brachial apparatus, and the alimentary canal terminates laterally with an anus. The latter have the valve joined by a simple straight slightly thickened margin, or by distinctly developed hinge-teeth and corresponding sockets; the shelly brachial apparatus is rudimentary or well developed, and the alimentary canal is believed to terminate blindly. The former group includes the families *LINGULIDÆ*, *DISCINIDÆ*, and *CRANIIDÆ*, and the latter the *PRODUCTIDÆ*, *CHONETIDÆ*, *STROPHOMENIDÆ*, *SPIRIFERIDÆ*, *RHYNCHONELLIDÆ* and *TEREBRATULIDÆ*. From the last the *THECIDÆ* have probably to be separated as a distinct family, and somewhat different arrangements have also been proposed regarding some of the palæozoic forms.

Of the eight families noticed, there are only three represented in the South Indian cretaceous deposits.

Family,—CRANIIDÆ.[*]

The animals of the single known genus *Crania* possess fleshy, spirally coiled arms, which are attached to the sides of a small sub-central process in the hæmal or dorsal (= upper) valve.

The shell consists of two sub-equal or unequal calcareous valves, of a minutely tubular structure, fixed to each other by two pairs of adductor muscles, but without any special hinge-teeth, or any solid brachial system in the hæmal valve.

Genus.—CRANIA, *Retzius*, 1781.

Davidson, Brit. Foss. Brachiopoda, vol. I, p. 122.
,, Class. der Brachiopoden, transl. by Suess, 1856, p. 137.

Shell sub-orbicular, or subquadrate, inequivalve, with the neural valve free or usually adherent, or attached to sub-marine objects with a larger or smaller portion of the surface; hæmal valve patelliform, with a sub-central or excentric vertex; outer surface smooth, concentrically or radiately striated or ribbed, inner with two sub-central anterior and two sub-marginal posterior adductor scars, the two in each pair respectively distant from each other; neural valve with two approximate sub-central anterior scars, generally separated by a dentiform, more or less prominent, ridge, and with two distant sub-marginal posterior scars; all the scars are rounded or roundish oval, and either somewhat impressed or situated on special thickenings of the shell; the neural valve generally has a narrow indistinct area at the posterior, somewhat truncate, edge; vascular impressions in both valves single, digitiform. (For the history of the genus, and the sub-divisions suggested by various authors, I must refer to Mr. Davidson's elaborate account in his classification of the Brachiopoda).

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[*] A revision of the genera of the family is given by Dall in Am. Jour. Conch., vol. vii, p. 71, and the synonymy of the recent species is noted.

The species of *Crania* occur from the oldest sedimentary formations up to the present time. They appear to have been, however, most numerous during the cretaceous period. Of recent species H. and A. Adams quote five, but the type of the genus is a cretaceous one from Maastricht, *Crania Brattenburgensis*, (Stobæus).

In the cretaceous rocks of Southern India a single species has as yet occurred, and this is a very widely distributed one, originally described by Retzius, the founder of the genus.

A list of the cretaceous species, as far as known, has been given by Schlœnbach in the "Palæontographica," Cassel, 1866, vol. XIII, pt. VI, p. 317; they are all European, or at least from the old continent; no species has, I believe, been as yet described from America.

CRANIA IGNABERGENSIS, *Retzius*, Pl. I, Figs. 1—2.

1781. *Crania Ignabergensis,* Retzius, Schriften der Berl. Akademie, II, p. 75, pl. I, figs. 4—7.
1847. *eadem,* d'Orbigny, Pal. Franç. terr. cret., IV, p. 141, pl. 525, figs. 1—6.
1852. *Crania Egnabergensis,* apud Davidson, British Cret. Brachiopoda, p. 11, pl. I, figs. 8—14 (cum. syn.).
1866. „ *Ignabergensis,* „ Schlœnbach, 'Palæontographica', 1866, XIII, p. 326 (cum. syn.).

Testa subquadrangulariter rotundata, seu rotundata, inæquivalvi; valva neurali aut planiuscula aut convexiore, solum prope apicem excentricum, seu parte majore, affixa; valva hæmali conoidea, patelliformi, plus minusve elevata, apice acutato, excentrico, nonnunquam submammillato instructa; superficie utriusque valvæ costulis 24-46, radiantibus, majoribus et minoribus alternantibus, striis concentricis intersectis, nonnunquam rugulatis seu imbricatim asperulatis, ad peripheriam paulo projicientibus, ornata; margine interno lato, subplano, granulato.

The neural valve is always attached, either by the apex or by a larger or smaller portion of its surface; it is also less convex than the hæmal or upper valve, in which the excentric apex is directed somewhat posteriorly. All the muscular scars are situated on considerable thickenings of the shell. The two anterior scars in the hæmal valve are either entirely separated by the median ridge, or they meet with each other in front of it.

The number of radiating ribs is very variable. The typical form from Ignaberg is distinguished by its usual roundly subquadrangular form and numerous subequal, or alternately shorter and longer, and thicker and thinner ribs, being 38-46 in number. This form is common in the Baltic Chalk, and it also occurs at Maastricht, though apparently rarely. The two as yet known South Indian examples agree well with this typical form, except that the ribs are slightly fewer in number. Specimens from Folkstone are similar in form, but have still fewer ribs.

At Maastricht another variety is more common; it has a more distinctly rounded shape, the ribs are either numerous, or they are few (24-28 only), and thick. This latter form has been designated as var. *paucicostata* by Bosquet, and some specimens of it are wider than long, while in typical *Ignabergensis* the opposite is the case, or at least the two diameters are equal. A third variety is figured by Schlœnbach (loc. cit., pl. xl, fig. 24), which has the numerous ribs of the type form, but is more rounded in shape than the last; the two valves are nearly equally elevated, or the neural is even a little higher than the hæmal.

There are besides two other varieties indicated by Schlœnbach. The one, *C. strix*, Kunth, fairly agrees with the last mentioned variety, and the other includes specimens figured by Davidson and Deslongchamps, attached by a broad surface of the neural valve.

C. Ignabergensis is found in England in the Upper and Lower Chalk; on the continent of Europe it occurs in the uppermost cretaceous deposits,—Danien and Senonien of d'Orbigny, Weisse Kreide and Oberer Plæner,—from Norway all through Germany, Belgium, Bohemia, and France.

Locality.—Olapaudy; only two specimens have as yet been found in a brownish oolitic rock.

Formation.—Arrialoor group.

Family,—RHYNCHONELLIDÆ.

The animal of *Rhynchonella*, the only genus known in a recent state, is either free, or attached to sub-marine objects by a muscular pedicle situated at the beak of the neural valve; the arms are spiral, fleshy, supported only at their base by short shelly processes; the muscular system consists of a strong adductor, divided dorsally into four branches and ventrally united into one; besides that, the usual cardinal and retractor muscles of the peduncle are present, but the latter is sometimes obsolete, in which case the retractor is equally so; the mouth is situated in the middle of a membrane, separating the small posterior visceral part from the anterior respiratory cavity; the alimentary canal passes through the notch of the hinge-plate and ends behind the point of insertion of the adductor near the centre of the neural valve; the pallial veins originate in four much sub-divided branches; the mantle is not attached to the shell, and its margins are provided with more or less numerous, fine, chitinous setæ.

The shells are inequivalve, very variable in shape and size, of fibrous or pyramidal, not punctate structure; the two valves are articulated by a pair of hinge-teeth; hæmal valve with two shelly brachial processes; neural valve with the beak pointed, incurved, perforated, or closed.[*]

Of the four genera[†] of this family, *Rhynchonella*, *Camarophoria*, *Pentamerus*, and probably *Dimerella* of Zittel, only the first one is represented in the South Indian cretaceous deposits.

RHYNCHONELLA, *Fischer*, 1809.

(See Davidson, British Foss. Brachiopoda, Vol. I, and Classificat. of Brachiopoda).

Shell very variable in shape, changing from triangular to elongately ovate or round; surface rarely smooth, usually radiately ribbed or striated; generally with a fold and sinus in front, rarely without them. Neural valve with a pointed, sharp beak, having a foramen on the inner side below the point, which is, however, occasionally so much turned upwards as to entirely close the perforation; deltidium small, partially or entirely surrounding the foramen, and sometimes forming a regular tube; hinge with two diverging cardinal teeth, supported by dental plates, extending to the base of the valve below, and enclosing a more or less marked depression in which the shell and peduncle muscle is attached, and below it is situated the large adductor scar. Hæmal valve with two apophysary flattened and grooved lamellæ, separated at the base and somewhat turned upwards; below it are the four adductor scars, separated by a short more or less developed ridge.

Species of *Rhynchonella* occur from the oldest sedimentary deposits up to the present time. Dall (American Journ. of Conch., vol. v, 1870, p. 151 and seq.) gives five recent species, *psittacea*, (Arctic Seas); *nigricans*, (New Zealand); *Grayi*, (Fiji Isl.); *Woodwardi* and *lucida*, (Japan), to which *R. sicula*, Seq., has to be added. It is very probable that the recent researches in deep sea dredging will considerably increase the number of these monuments of ancient animal life.

I can distinguish from the South Indian cretaceous beds six different species, most of which exhibit close affinities to others from the Upper Greensand and Chalk deposits of Europe, but only one of the species appears to be really identical. Possibly, when more extensive materials have been collected, the identification of some of the other forms may be ascertained, which must, at the present moment, be considered as new to science.

1. RHYNCHONELLA MUTUA, *Stoliczka*, Pl. 1, Figs. 3-4.

Rhyn. testa transverse irregulariter subovata, tumida; valva hæmali alterâ multo convexiore; umbone parvo; fronte semipartita uniforme deflexa; superficie crassecostata: costis circiter 16, *sub-obtusis, fere, æquidistantibus, sublævigatis, prope umbonem obsoletis;* 16 *mm. longa*, 18 *lata*, 10·5 *crassa.*

? Variatio—valva neurali subtrigona, costis circiter 12, *crassis, acutis, striis incrementi lamellatis intersectis, usque ad apicem extensis;* 20 *mm. longa*, 22 *lata.*

The typical form, represented in fig. 3, is a transversely subovate, tumid shell, with the hæmal valve much more inflated than the neural one, the latter having a somewhat small beak with the umbonal ridges rounded, and forming an angle of 110°; the termination of the beak itself is not preserved in the single specimen which we have. The front is divided in the middle, one-half being somewhat bent upwards and the other downwards, gradually, not rapidly. The surface is marked with about 16 strong, equidistant, and almost smooth radiating ribs, which become obsolete (or nearly so) towards the umbones; they were evidently obtusely angular, but as the surface is not well preserved, it is difficult to say whether they were very sharp in the original state.

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[*] It is probably only in aged specimens that the foramen becomes closed.

[†] Also *Rhynchopora* and probably *Hemithyris*; compare Dall in Am. J. Conch., 1871-1872, vii, p. 69.

Locality.—Sirgumpore, in a white limestone.

Formation.—Ootatoor group.

Var. A single neural valve has been found in a conglomeratic limestone near Ootatoor. This valve belongs to a somewhat more triangular, larger shell, resembling the last in general character, but having only about 12 radiating ribs, which are very sharp and reach up to the umbo; the ribs also are crossed by lamelliform striæ of growth. A fragment of a hæmal valve from the same locality is equally inflated as that of the typical form from Sirgumpore; the ribs are very sharp near the periphery, but considerably less so towards the umbo.

Formation.—Ootatoor group.

Although there appears at the first sight to exist a great difference between the two forms, I think it highly probable that they represent only one species, and that in the typical specimen the ribs are accidentally a little worn down.

The species resembles in form some varieties of *Rhyn. dimidiata*, Sow., but differs from them by its coarse ribbing. In this point it approaches *Rhyn. Becksi*, Schlœnbach, (Neues Jahrb. für Mineralogie, &c., 1869, p. 825), being readily distinguished from this one, however, by the unequal convexity of the valves. The nearest approach that I can find to our fossil is the jurassic *Rhynch. pinguis*, which differs solely by the more incurved pointed beak, and better developed umbonal ridges.

2. RHYNCHONELLA ARRIALOORENSIS, *Stoliczka*, Pl. I, Figs. 5-6.

Rhyn. testa rotundate subtrigona, tumida, valva hæmali alterâ convexiore, radiatim costata, costis 22-26, crassis, subacutis, sublævigatis, interstitiis multo angustioribus separatis; fronte obtusata, medio late sinuata; sinu subquadrangulari, moderate profundo, 4-5—costato; valva neurali umbone parvo, acuto, breviter incurvo.

A tumid roundly subtrigonal shell, the hæmal valve being somewhat more convex than the other; both, however, are rather abruptly truncate all round the margins, and are interlocked with strong pointed teeth. The front has a broad almost rectangular sinus in the hæmal valve; it is 5-6—costate, slightly wider than one-third of the total width of the shell, but not so high as the general convexity of the hæmal valve. The surface is ornamented with from 22-26 radiating, strong, subequal, and very closely set ribs, which are slightly angular and crossed by very fine striæ of growth; all the ribs begin at the apex of each valve respectively. The apex of the neural valve is moderately prominent, pointed, and so much incurved that the very small foramen is hardly visible in the perfect shell; the deltidium is small, tubercular in front, and apparently extends all round the foramen; the umbonal ridges are slightly marked, short, curved, meeting at an angle of about 95°; they enclose a short smooth area on either side of the umbo, slightly encroaching with its margin on the hæmal valve.

Locality.—S. E. of Arrialoor; only a few specimens have been found in a whitish sandstone.

Formation.—Arrialoor group.

This species appears to be the eastern representative of *Rhyn. Mantellana*, from the more inflated varieties of which it differs by a well developed frontal sinus, and by having the radiating ribs somewhat more numerous and generally closer together; the beak also is considerably more incurved. Almost the same differences are applicable in a comparison with *Rhyn. ventriplanata*, which Schlœnbach separated from the last mentioned species (comp. Sitzungsb. Akad., Wien, Math. Nat. Klasse, LVII, p. 215, pl. 3, figs. 8-10).

3. RHYNCHONELLA COMPRESSA, *(Lam.)* Pl. I, Fig. 7.

1819. *Terebratula compressa*, Lam., An. s. vert., vol. vi, p. 256.
1847. *Rhynchonella compressa*, D'Orb., Pal. Franç. terr. cret., vol. iv, p. 35, pl. 497, figs. 1—6, (non *eadem* apud Davidson, Brit. Cret. Brach., p. 80.)

Rhyn. testa transverse elongate sub-ovata, valva hæmali alterá multo convexiore, ad umbonem maxime elevata, ambabus margines versus valde depressis; superficie radiatim 20-26 *costata; costis crassiusculis, sub-lævigatis, sæpissime simplicibus, rare dichotomis; fronte profunde insinuata; sinu* 7-10—*costato, circiter tertiam partem latitudinis testæ æquante ac planitiem valvulæ hæmalis fere attingente; umbone valvæ neuralis depressæ modice projiciente, subrecto; deltidio parvo, foramen omnino circumdante.*

In identifying an Indian specimen with the European species, I adopt Dr. Schlœnbach's views regarding the distinction of the original *Rhyn. compressa* of Lamarck and of D'Orbigny, and that named *Rhyn. dimidiata*[*] by Sowerby, and recorded by Davidson in his Brit. Cret. Brachiopoda under the former name. In *Rhyn. compressa* the neural valve is very flattened and the hæmal most convex near the apex, but both valves are considerably flattened towards the margins, the sinus equals in width about one-third the breadth of the shell, and is shallower or deeper, but scarcely reaching the level of the convexity of the hæmal valve; the beak of the neural valve is straighter than in *dimidiata*, and the umbonal ridges less developed; the radiating ribs are mostly simple, very rarely bipartite, and, therefore, considerably stronger at the periphery than in the middle of the shell; the shell is very thick, and cast specimens appear to be, therefore, much less distinctly ribbed than could be presumed from the original surface. The geological position of *R. compressa* in France is generally above the zone with *Ammonites Rotomagensis*. All these characters so entirely agree with the Indian shell and its geological position that they leave barely a doubt as to its identity with Lamarck's species.

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[*] With which Schlœnbach also identifies *R. latissima*, and part of *R. depressa* of Davidson; Geogn. Palæont. Beitræge, by Benecke, 1868, vol. I, p. 486, and seq.

Locality.—West of Andoor, in a brownish calcareous sandstone; only one specimen has as yet been found.

Formation.—Trichinopoly group.

4. RHYNCHONELLA CRENIFERA, *Stoliczka*, Pl. I, Figs. 8—10.

Rhyn. testa transverse elongata, sub-tetragona seu sub-trigona, modice depressiuscula, valva hæmali alterâ paulo convexiore, marginem versus gradatim descendente; superficie radiatim multi–costulata; costulis* 45—70, *tenuibus, subæqualibus, media parte sæpissime simplicibus, lateraliter plerumque dichotomis, omninis striis incrementi squamiformibus dense crenatis, aut partim intersectis; sinu anteriore modice profundo, tertiam partem latitudinis testæ paulo superante,* 18—30–*costulato; umbone valde projiciente, subrecto, acutato, foramine magno instructo; deltidio moderato, foramen fere omnino circumdante.

This is a well marked species of a *Rhynchonella,* somewhat intermediate between *R. dimidiata,*—particularly the form described by Davidson (Brit. Cret. Brach., p. 82, pl. xi, figs. 6—14) as *R. latissima,* Sow.,—and *R. depressa,* Sow. With the former the Indian species partly agrees in having numerous fine ribs, and with the latter in possessing an almost straight and greatly extended beak; the more elongately transverse form, and the peculiarly scaly, crenated ribs, however, readily separate it from both the European forms. The size of the shell varies as usually, and so do also the respective convexities of the valves.

The frontal sinus generally extends over more than one-third the width of the shell; in some specimens it nearly reaches the level of the convexity of the hæmal valve, in others it distinctly does not so. The beak ridges are well marked, meeting at an angle of about 105°; in their course they are slightly concave, and the area between them and the margin of the valve on each side is also somewhat excavated, well marked with coarse striæ of growth, and at the junction of the deltidium with a thin, slightly crenulated ridge.

Localities.—S. E. of Arrialoor and S. W. of Mulloor, in whitish sandstone; a few specimens from the former and one from the latter were examined.

Formation.—Arrialoor group.

5. RHYNCHONELLA NUTANS, *Stoliczka*, Pl. I, Figs. 11, 12, 13.

Rhyn. testa subrotundata seu transverse et sub-trigone oblonga, inflata, marginibus rapide declivis; valva hæmali altera convexiore, semiglobosa, superficie radiatim numerosissime costellata, costellis* 70—80, *ad apices orientibus, lævigatis, partim simplicibus, partim dichotomis, æquidistantibus et sub-æqualibus; fronte modice

sinuata, sinu circiter 20—25 *costato; valva neurali apice acuto, valde incurvo, foramine moderato, ovali, deltidio parvo, medio indistincte sulcato, fere omnino circumdato instructa; costis umbonalibus angulatis, distinctis, aream in utroque latere brevem, concavam, lævigatam, marginantibus.*

The form of the shell of this species is subject to somewhat similar variations, as that of the European *Rhyn. Cuvieri* and *Grasana*, from both of which it is readily distinguished by the much finer and more numerous costulations, and by the strongly incurved, pointed, and comparatively small beak of the neural valve, which is also laterally much less indented than is, for instance, the case in *R. Cuvieri.*

The hæmal valve of *R. nutans* is somewhat more convex than the neural one, the frontal sinus is moderately depressed and never reaches the level of the convexity of the former valve; it is marked by about 20 or 25 ribs. The beak ridges meet under an angle of about 100°, are slightly concave, and enclose between them and the hinge margin of the valve a moderately excavated, smooth area.

The foramen is elongately ovate and entirely surrounded by the deltidium, which is, however, very thin on the apical side of it, and hardly meeting with its two branches, while on the hinge side it is indistinctly grooved along the middle. The hinge-teeth of the neural valve are tubercular, strong, and about four millim. distant from each other.

Locality.—South by West of Mulloor; four specimens have been obtained in a white, highly calcareous, sandstone.

Formation.—Arrialoor group.

6. Rhynchonella plicatiloides, *Stoliczka*, Pl. I, Figs. 14—28, and Pl. II, Figs. 1—6.

Rhyn. testa transverse plus minusve late obovata, brevissime rostrata, valva hæmali altera multo convexiore, medio maxime elevata, lateraliter leviter declivi; valva neurali antice abrupte lateque depressa, postice parum tumidula atque umbone brevi, acuto et valde incurvo, instructa; fronte subtruncata, fere simplici vel multiplicatula, medio profunde sinuata; sinu tertiam partem latitudinis testæ æquante, planitiem convexitatis valvæ hæmalis attingente, vel sæpius breviore, supra angulatim et late truncato, seu rarius fere uniforme convexo; superficie rarissime costulis crassiusculis, circiter 34, *tecta, plerumque multicostulata,* costulis circiter 50-80, *partim simplicibus partim dichotomis, æqualibus, in junioribus numerose squamulosis, in adultis aut lævigatis aut peripheriam versus lineis incrementi (una vel pluribus) abrupte intersectis; foramine parvo, infra et lateraliter deltidio marginato, marginibus lateralibus acute elevatis; jugis umbonalibus valvæ neuralis parvis, flexuose curvatis, aream in utroque latere angustissimam marginantibus.*

This species so closely resembles the well known *Rhyn. plicatilis*, Sow., as restricted, and distinguished* from *Rhyn. octo-plicata*, Sow., that I was for a long time in doubt whether there existed sufficient reason for separating both specifically. However, the constant very small size of the beak in the Indian form, as observed in several hundreds of specimens, from at least a dozen of different localities and from distinct beds, appears to me to indicate the validity of a species distinct from the European fossil. During the process of growth the shell is subject to a very large amount of variation, which will be better understood by an inspection of the figures, than by a lengthened description. In all cases, however, is the shell broader than long, unless it be due to an accidental deformity. Young specimens are often very flat, only with an indication of the frontal sinus. In growing larger either the breadth or the convexity of the valves increases at a greater ratio, and, according to this, varies also the depth and width of the frontal sinus, which sometimes is very abrupt. The hæmal valve is always considerably more convex than the neural one, which is only slightly tumid towards the beak, but not to the same extent as usually seen in specimens of *plicatilis.*

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* Comp. Schlœnbach in Sitzungsb. Akad., Wien, Math. Nat. Klasse, 1868, vol. LVII, p. 218, and Jahrb. für Mineral., 1869, p. 822.

Equally variable, as is the form, is also the ornamentation. When the surface is well preserved, the ribs always show some kind of a scaly crenulation, which is produced by their being abruptly intersected or crossed by lines of growth, and at each such intersection the edges of the ribs are sharply turned upwards.

In younger specimens these lines of growth are sometimes almost as numerous as in *R. crenifera,* in others they are more distant, but in older specimens there are generally only two to four of them present towards the margin of the valves, and the ribs, unless very well preserved, are mostly smooth. Among several hundred specimens I only found one which has the radiating ribs rather strong and about 34 in number. A few specimens from the same bed and locality, and also some others have about 50 radiating ribs. But in the majority the number is about 60, in some it rises as high as 80, and in one large one from Anapaudy I counted 90. A comparatively greater number of specimens belonging to the present species is much more finely ribbed than the European *plicatilis.*

An important distinction of *plicatiloides* is, as already observed, the small size of the beak, the beak ridges being always conspicuously concave and just visible in a hæmal view of the shell; very rarely are their edges sharp, and the area between them and the hinge-line on either side is about three quarters of a millimeter broad.

The beak ridges meet at an angle varying from 115° to 135°. The cardinal teeth of the neural valve are thin, but long; the brachial apophyses of the hæmal valve are, as usually, turned upwards, somewhat broader at their ends, and on the inner side provided with a shallow groove. Both, hinge-teeth and the apophyses, are comparatively closer together than in *R. plicatilis.*

Localities.—Shalanure, in earthy ferruginous beds, at the base of the Trichinopoly group, very common; Andoor, south-west of Veragoor, Kullay, south-west of Koloture, Kolakonuttom, &c., (all in Trichinopoly group); Ootacoil, common; Olapaudy, Comarapolliam, Karapaudy, Shillagoody, &c. (Arrialoor group).

Formation.—Trichinopoly and Arrialoor groups; more common in the former than in the latter.

Family,—TEREBRATULIDÆ.

The animals are in this family always temporarily attached to sub-marine objects by a fleshy peduncle,* which is protruded through the foramen of the larger valve. The mantle margins are finely ciliated, and the oral appendages supported by solid, shelly, but not spirally twisted, arms, which form a more or less complete loop, always attached to the smaller, or hæmal, or brachial valve.

The shell is always punctated, variously, but generally not richly ornamented; the two valves are joined to each other by two strong hinge-teeth, situated in the larger or neural valve, corresponding to two pits in the smaller or hæmal one, the former being always perforated at the posterior end by a foramen, which is anteriorly partly margined by the deltidium.

The last revision of the genera and sub-genera belonging to this family was given by Dall in American Journ. of Conch.,† vol. vi, p. 96, &c. The author divided it into seven sub-families, *Terebratulinæ*, *Stringocephalinæ*, *Magasinæ*, *Krausininæ*, *Platidiinæ*, *Megathyrinæ*, and *Thecidiinæ*; the last is considered doubtful and should form a separate family, as already suggested many years ago by Davidson. Of the other sub-families the typical genera are respectively *Terebratula*, *Stringocephalus*, *Magas*, *Kraussina*, *Platidia*, and *Megathyris*.

To repeat here all the other genera and sub-genera does not appear necessary, and I refer to Mr. Dall's detailed statements (l. cit.) regarding each of them.

The *TEREBRATULIDÆ* are represented in all sedimentary formations from the Silurian up to the uppermost tertiary beds, and they also include the majority of the species of Brachiopoda yet found living in different seas.

In the South Indian cretaceous rocks only three genera are represented, *Terebratula*, *Terebratulina*, and *Kingena*. Of the first nine species occur, of the second only one, and of the last four.

Genus,—TEREBRATULA, *Lhwyd*, 1696.

Davidson, Brit. Fossil. Brach., vol. I, Introduct., p. 62.

Shell generally ovate, rounded, subpentagonal or subtriangular, with the valves smooth, striated or ribbed; beak of neural valve truncate by a rounded or ovate foramen; deltidium simple or divided by a median suture in two pieces; loop short, the two principal arms, or crura, united at their anterior end, but the median projections only converge towards each other without meeting.

Nine species of this genus are represented in the cretaceous strata of Southern India; of these six appear to be identical with those occurring in Europe.

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* Rarely by a portion of the shell itself.

† With additions, *ibidem*, vol. vii, p. 61, et seq.

1. TEREBRATULA DEPRESSA, *Lamarck*, var. *cyrta*, Walker, Pl. II, Figs. 7—8.

1819. *T. depressa*, Lam., An. s. vert., vol. vi, p. 249.
1846. *T. arabilis*, Forbes, Trans. Geol. Soc., Lond., vol. vii, p. 138, pl. xviii, fig. 12;—*eadem*, D'Orb., Prod.
1852. *T. depressa*, apud Davidson, Brit. cret. Brach., p. 70, pl. ix, figs. 9—24. (cum. syn.).
1868. „ „ „ Schlœnbach, Geog.-Palæont. Beitræge by Benecke, &c., vol. I, p. 447 (cum. syn.).
1868. „ „ „ Walker, Geol. Mag., vol. v, p. 403, pl. xviii, figs. 1—2.

T. testa sub-ovata seu sub-rotundata, sub-depressa; valvis fere æqualiter convexiusculis, striis incrementi tenuibus, nonnullis sæpe sub-rugosis interpositis, tectis, radiatim minute striolatis; umbone levissime incurvo, foramine magno, truncato, lateribus umbonalibus sub-rotundatis, fronte impressis; deltidio magno, simplici, sæpissime longo, rare brevi, facie convexiusculo; fronte valvarum in adultis speciminibus plus minusve distincte sinuata.

There are only three specimens which I am able to refer to this well known European species, and all three are from the Ootatoor beds, the lowest of the South Indian cretaceous deposits, as at present known. One, a young specimen, has no distinct frontal sinus, but the two other specimens have it distinctly indicated, a character which is also clearly shown in Forbes' figure of *arabilis*, and which I consider to be one of the most distinctive in a comparison with the next species.

The very fine radiating striation, to which attention has been drawn by the late Dr. U. Schlœnbach, is also noticeable in the South Indian specimens, but it also occurs in several other species. The beak of the neural valve is always slightly incurved, and obliquely truncate by a large foramen. The beak ridges are rounded or moderately angular, and the frontal area on either side flattened and depressed. The size of the deltidium varies; generally it is large, trapezoid, and on the frontal surface somewhat convex; more rarely it is short, as shown in some specimens from the Upware Greensand, designated by Walker (loc. cit.) as 'var. *cyrta*.' To these specimens the Indian form undoubtedly exhibits the closest resemblance. As regards the greater convexity of the valves, there does not appear to be any sensible difference from the Lamarckian type.

T. depressa occurs in England in the (? Lower) Greensand at Upware, Potton, and Faringdon; in Belgium, and various parts of Germany, it is a characteristic fossil of the Tourtia and Lower Plæner, corresponding to D'Orbigny's Cenomanien, and exactly in the same beds it also occurs in India.

Locality.—North of Odium, in a yellowish brown earthy limestone; rare.

Formation.—Ootatoor group.

2. TEREBRATULA SUB-DEPRESSA, *Stoliczka*, Pl. II, Figs. 9—16; Pl. III, Figs. 1—8.

Ter. testa elongata seu late ovata, modice depressa; valvis nonnunquam fere æqualiter convexiusculis, sæpiusque valva neurali (= umbonali) alterâ paulo convexiore; superficie concentrice distanter subrugose striata, radiatim densissime striolata, striolis sæpe indistinctis vel omnino obsoletis; umbone mediocri, crasso, leviter incurvo atque foramine lato et sub-rotundo truncato, deltidio brevi, modice latiusculo, *a margine foraminis rapide declivi atque sulco profundo ab apice valvæ hæmalis separato; lateribus umbonalibus rotundate sub-angulatis, paulo concavis; area in utroque latere depressiuscula, indistincte definita; peripheria valvarum undique simplici, fronte haud insinuata.*

This may justly be regarded as an offspring of the older *depressa*, with which I would have identified it, were it not that all the specimens (and there are several hundreds of them from various localities) from the higher beds entirely want the frontal sinus, and there is also no trace of an insinuation or overlap at the lateral margins, which is invariably more or less distinctly traceable in *depressa*. The more or less elongate or ovate form of both species is very similar and equally variable, the shells being often inclined to a symmetry, but in *sub-depressa* the brachial or hæmal valve is generally slightly less convex than the other. The margins are thin and acute in young, thickened or conspicuously truncate in very old ones. The surface generally shows distinct, sometimes slightly rugose, striæ of growth, and besides a fine, somewhat undulating or irregular radiating striation, similar to that of *T. depressa, obesa, disparilis*, and others. The beak in *sub-depressa* is always more convex or incurved than in any specimens of *depressa* I have examined, the deltidium is much shorter than in the ordinary *depressa*, but agrees in that respect with var. *cyrta* of the latter species, except that it is always very rapidly descending, and therefore separated from the apex of the hæmal valve by a deep sulcus.

The loop must have been very short, almost shorter than in *depressa*, the two hæmal arms being at the beginning nearly parallel and very close to each other; further on they diverge, but the terminal end has not been seen preserved (see fig. 15 on pl. ii). The sockets for hinge-teeth of the neural valve are internally bounded by rather sharp and thin ridges. Below the loop on the inner side of the brachial or hæmal valve there is a slight ridge, separating the two rather elongate chief muscular scars, at the outer side of which are the branched vascular impressions (see fig. 16 on pl. ii).

Localities.—Very common at Arrialoor, north of Poodoopolliam and at Vailoor; rare near Chockanadapooram, north and south-east of Ootacoil, everywhere either in a whitish calcareous sandstone, or a similarly colored impure limestone.

Formation.—Arrialoor group, apparently a very characteristic species of this division.

A peculiar variety, figured on plate II, fig. 14, deserves special notice. It is from the Arrialoor sandstones, south-east of the town of Arrialoor, and is distinguished from all the other specimens by a remarkably flattened and rounded form, the angle at the beak being above 100°. The deltidium appears to be very small, but the edge of the foramen is unfortunately not quite perfect. The surface is marked with sub-distant bands of growth and very dense wavy concentric lines, and is besides very densely punctated between them; the margins of the valves are in their entire circumference perfectly straight.

3. TEREBRATULA *conf.* CARTERI, *Davidson*, Pl. IV, Fig. 1.

1852. *T. Carteri*, Davidson, Brit. Cret. Brach., p. 72, pl. vii, fig. 3.
1868. „ Schlœnbach, Sitzb. Akad., Wien, Mat. Nat. Klasse, lvii, p. 206.
1869. „ „ in Jahrb. für Mineralogie, &c., p. 828.

The only specimen from Southern India so agrees, as far as preserved, in all essential particulars with *T. Carteri*, that I think its identity with that European species highly probable. *T. Carteri* is characterized by an elongated form, the greatest width lies somewhat in front of the middle and is about equal to two-thirds of the total length; the hæmal valve is slightly less elevated than the neural one, the former being somewhat broadly insinuated in front, while the latter is correspondingly produced and bent upwards; at the sides near the front the neural valve is somewhat indented by an overlap of the hæmal one; the surface is smooth, marked with some slightly elevated concentric striæ of growth, when well preserved, and, as usually, finely punctated. In Davidson's type the beak is very short, incurved, truncated by a moderately sized foramen, the deltidium is hardly traceable, beak-ridges and area not developed. Schlœnbach says that he examined specimens from the so-called "Galeriten Schichten" (Upper Plæner), which in form perfectly agree with Davidson's type, the average largest size, however, being only 30 mm., instead of 40, but there were also some other specimens in which the beak was slightly more produced and the deltidium perfectly well visible; no beak ridges or area were, however, defined. The specimen from Southern India has the beak unfortunately broken off, but there is distinct indication that it must have been as short as in Davidson's type, while the size of the shell agrees with that of Schlœnbach's specimens.

I should also mention that a similar species of a *Terebratula* has been described by Tate from the Irish cretaceous deposits as *T. abrupta*, but the hæmal valve is near the anterior end deeply sulcated in the middle (Quart. Jour. Geol. Soc., London, 1865, xxi, p. 41, pl. v, fig. 1). Meyer's *T. extensa* (Geol. Mag., 1864, i, p. 252, pl. xii, figs. 1—4) possesses still more similarity with *T. Carteri*, but the greatest width in this species is above the middle, and the anterior end is somewhat more produced.

T. Carteri is recorded from the Grey Chalk near Dover (Dav.), and from the Upper Plæner of various parts of Germany (Schlœnbach, l. cit.).

Locality.—The single South Indian specimen is from the brownish earthy calcareous beds east of Olapaudy, recorded on the map as belonging to the Arrialoor group, but resting immediately on the Ootatoor beds, so that some of the fossils from this locality might with equal probability have been derived from the lower beds.

Formation.—Arrialoor group (?)

4. TEREBRATULA BIPLICATA, *Sowerby*, Pl. IV, Figs. 2—17; Pl. V, Figs. 1—3.

1815. *Ter. biplicata*, Sow., Min. Conch., vol. i, p. 201, pl. 90 (non *Anomia biplicata*, Brocchi).
1852. „ „ apud Davidson, Brit. Cret. Brach., p. 55.
1868. „ „ „ Schlœnbach, Benecke's Geogn. Palæont. Beiträge, vol. i, p. 433 (cum syn).

T. testa ovata seu elongate ovata, antice sæpissime sub-truncata atque plus minusve distincte biplicata, rariter fere simpliciter insinuata; valvis fere æqualiter convexis, aut valva umbonali alterâ paulo convexiore atque lateraliter in parte anteriore plus minusve profunde insinuata; superficie aut glabra aut concentrice subsulcate striata; umbone tumido, obtuso, valde incurvo, foramine rotundato atque moderate patulo et crasse marginato truncato, deltidio brevi, nonnunquam brevissimo, modice lato, simplici, antice abrupte declivi.

There are few other species of Brachiopods which have caused greater confusion and more controversies among Palæontologists than this one, which represents a large group of the so-called biplicate *Terebratulæ*. The various opinions of different authors have been recently most ably discussed by the late Dr. Schlœnbach (l. cit.), and it is not necessary to repeat them here.

I will only mention that from the examination of Brocchi's type specimen by Sæmann and Triger,* it appears clear, that Brocchi's name *Anomia biplicata* cannot be applied to the cretaceous species, originally described by Sowerby as *Terebratula biplicata*. The former is believed to be probably identical with Sowerby's liassic *T. intendata*, but as this identification cannot be ascertained with sufficient accuracy, and, moreover, as that species belongs to a different section of *Terebratula*, every objection against retaining Sowerby's denomination for the cretaceous form is removed; and it appears most judicious to drop Brocchi's name altogether.

T. biplicata is easily recognised from its allies by the moderately tumid form of the shell and the strongly incurved beak, perforated by a foramen of moderate size. Beak ridges and area are never distinctly developed. The size of the full grown typical form (pl. iv, figs. 2—4, figs. 10—13) is generally moderate, between 30 and 40 mm. long, 22—28 mm. wide, and 18—22 mm. thick; the greatest width being usually a little in front of the middle, and the greatest thickness at or very near the middle. The biplication of the front and the lateral encroachment of the brachial, or hæmal, valve upon the median insinuation of the neural valve is always traceable, but the degree to which this extends is very variable. In some specimens (figs. 10—11) it is only slight, in others (and these are perfectly identical with the type), it is more distinct (figs. 4 and 13). The surface is usually smooth, very finely punctated and marked with more or less distinct striæ of growth. Rarely also a fine radiating striation is to be observed in places. The loop is simple, and equals about one-third the length of the brachial valve.

In connection with the stronger concentric ornamentation, I may notice the peculiar variety which Davidson describes under the name *T. sulcifera* of Morris, and which Schlœnbach identifies with *T. biplicata*, Sow. As regards general form there certainly appears to be little difference between the two, but it seems to me probable that Davidson included in his *sulcifera* also specimens which belong to D'Orbigny's *disparilis;* at least some French and English specimens commonly called *sulcifera* unmistakably belong to D'Orbigny's species.

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* Bull. Soc., Géol., 1861-62, vol. xix, p. 160.

Locality.—The typical *biplicata* occurs only in the grey or reddish, partly conglomeratic, sandstone south-east of Mulloor, and in a whitish sandstone south of the same place. Both localities belong to the Arrialoor group.

A peculiar variety may be recorded as *T. biplicata* var. *Karapaudiensis*, pl. iv, figs. 5—9. This form also occurs in the Arrialoor beds, at Karapaudy in a light grey sandstone. The young shell is elongately ovate with a narrow, but stout beak, much resembling that of *T. obesa;* it also has distinct traces of radiating striæ, but the valves are not so tumid as in the last named species. The older shell is very much elongated, resembling in shape the smaller specimen figured by D'Orbigny as *Dutempleana*. The front is truncate and distinctly biplicate, as in the typical form of *biplicata*.

A third still more marked form is D'Orbigny's original *Dutempleana*, and must be designated as *T. biplicata*, var. *Dutempleana*, pl. iv, figs. 14—17; pl. v, figs. 1—3. This variety has the posterior part of the shell towards the beak markedly contracted and attenuated, the surface with a rather distinct radiating striation, and generally with a broadish and shallow frontal sinus. It attains a larger size than any of the other varieties, and some forms when accidentally flattened closely resemble the ovate varieties of *T. sub-rotunda*, but the umbonal ridges are never developed, and the beak itself is larger than in the latter species. From equally large specimens of *obesa*, it differs by its less tumid beak, smaller foramen, and usual lesser convexity of the valves.

As in England and Germany, the var. *Dutempleana* generally occurs in Southern India in lower beds than the typical *biplicata;* it is not uncommon in several places in the neighbourhood of Andoor and Veraghoor, in beds which are referred to the Trichinopoly group; only one specimen is from near Olapaudy, from beds usually said to belong to the Arrialoor group, but this is not quite certain,—they may with almost equal probability be referred to the Trichinopoly group.

In England *T. biplicata* occurs in a very great number of varieties in the Upper Greensand and Chalk, which correspond to Cenomanien, Turonien, and the lower beds of the Senonien. In Germany it is also very common in the Cenomanien and Turonien, (Unterer and Oberer) Plæner, with *Am. Rotomagensis*, *varians*, and *Mantelli*, &c., while its occurrence in the uppermost cretaceous strata, as well as in the Gault, is considered as doubtful. In India we find, as already stated, the var. *Dutempleana* in the Trichinopoly group, corresponding very closely to the European Turonien or Upper Cenomanien, while the typical *biplicata* is sparingly found in the lower sandstones of the Arrialoor beds, equivalent to the Senonien. There is not a single specimen as yet known from our Ootatoor, or *Rotomagensis* beds, which represent the true Cenomanien, unless *T. obesa* be looked upon merely as a variety of *biplicata*.

5. TEREBRATULA OBESA, *Sowerby*, Pl. V, Figs. 4—5.

T. obesa, Sow., apud Davidson, Brit. Cret. Brach., 1852, p. 53, pl. v, figs. 13—16.

***T.** testa elongate ovata, valde tumida, valva umbonali alterâ paulo tumidiore, superficie minute punctata, concentrice sub-distanter striata atque radiatim striolata; fronte late insinuata aut plus minusve distincte biplicata; umbone valde tumido incurvo, foramine magno, sub-rotundato et crasse marginato, oblique truncato, antice producto atque sub-sulcato; deltidio simplici, brevissimo, aut omnino obtecto.*

In recording this species from Southern India, I entirely agree with what Davidson says regarding the same. It is hardly necessary to repeat all that author's observations. The species is very closely allied to the typical *biplicata*, and might be regarded only as a large variety of it, but the umbo is more tumid and thick, obliquely truncate by a large foramen, the lower lip of which is generally sulcated, and so much produced that it nearly, or entirely, conceals the deltidium. The surface is distinctly radiately striated, particularly near the lateral margins. The species appears to be local, and I only retain it provisionally under its old name, as distinct from the former, because I have only a few specimens for comparison, and also because their geological position is somewhat different from that of *biplicata*.

Locality.—There are only three large specimens in the collection, all from the ferruginous beds of the Ootatoor shales, east of Ootatoor. The slight variations observed in their form are exactly similar to those which have been noticed by Davidson.

Schlœnbach (Benecke's Geogn., Palæont. Beitræge, 1868, vol. i, p. 438, &c.) restricted the name *obesa* for the form which occurs in the Chalk, referring at the same time Davidson's figure, (16, loc. cit.) which represent an Upper Greensand specimen, to *biplicata* as a gigantic variety. This seems to me hardly correct, whatever opinion there may exist as to the exact geological position of one or the other of these forms. Judging from the three views 16, 16*a*, 16*b* of Davidson, I can see nothing which would indicate a specific distinction from the form represented in figs. 15 and 15*a* on the same plate. I, therefore, consider with Davidson the Chalk and Upper Greensand form as identical, and the geological horizon of the latter corresponds to that in which we find it in India.

Schlœnbach (loc. cit.) also identifies Hagenow's *T. Sowerbyi* with *obesa*, the former being found in the uppermost cretaceous strata of Rügen and also occurring at Maastricht. I have a specimen of true *Sowerbyi* from the latter locality, and this, when compared, for instance, with one of *obesa* from the Chalk near Dover, shows remarkable distinctions. *T. Sowerbyi* is much more attenuate towards the beak, which itself is much less incurved and more broadly truncate, and the areal portions on each side are more flattened. Exactly similar distinctions can be seen in Schlœnbach's *T. obesa* from Rügen (Benecke's Geog., Palæont. Beitræge, 1868, vol. i, pl. xxi, fig. 7); it also appears to be a less tumid species. In true *obesa* the beak is almost entirely incurved to the front. I am, therefore, inclined to regard *T. Sowerbyi*, Hag., as specifically distinct from *T. obesa*, Sowerby.

Formation.—Ootatoor group (beds of *Am. rostratus*, &c.).

6. TEREBRATULA SUBROTUNDA, *Sowerby*, Pl. VI, Figs. 1—23.

1813. *T. subrotunda, subundata* et *semiglobosa*, Sowerby, Min. Conch., i, pp. 45, 47, 48, pl. xv, figs. 1, 7, 9.
1852. *T. semiglobosa*, apud Davidson, Brit. Cret. Brach., p. 64, pl. viii, figs. 6—18 (cum. syn.).
1868. *T. subrotunda*, apud Schlœnbach, Sitz. Akad., Wien, Math. Nat. Klasse, vol. lvii, pt. i, p. 199, pl. 1, figs. 6—12 (cum. syn.).

Ter. testa sub-rotundata seu elongate ovata, medio modice dilatata, margine frontali in speciminibus junioribus simplici seu paulo insinuato, in adultis plerumque distinctius sinuato aut leviter biplicato; valvis fere æqualiter et modice convexis, seu valva umbonali alterâ paulo convexiore; superficie lævigata, minute punctata, striis incrementi nonnullis ad intervalla notata, interdumque radiatim obsolete striolata; umbone modice incurvo, lateribus plus minusve acute angulatis seu subcarinatis, angulum* 95°—105° *formantibus; foramine rotundato, minuto seu moderato, labio antice plerumque paulo producto, deltidio brevissimo, abrupto, medio sutura vix conspicua diviso.

This well known species is equally common and equally variable in form in the South Indian cretaceous deposits, as it is in European strata of the same age. The more depressed shell, less prominent and less incurved beak, terminating with a smaller foramen, and generally provided with rather distinct umbonal ridges, readily distinguish the species from *T. biplicata*, even when the frontal biplication of the margin is more distinctly marked than is usually the case.

Davidson and Schlœnbach (loc. cit.) have discussed the varied relations of this species to others at great length, and the latter author also pointed out that there does not exist sufficient reason for separating from *Terebratula* the species with a small foramen, &c., under a sub-generic denomination, *(Epithyris)*, as suggested by McCoy and supported by Deslongchamps. It is not necessary to repeat here those statements, but I will briefly note the chief variations under which the species is met with in different beds of the South Indian cretaceous deposits.

As a general distinction I may notice, that there never appear to occur in India such short and semiglobose forms as are commonly found in England and Germany, and that in the former, as a rule, the beak is not quite as much incurved, as usually seen in European specimens. The latter character distinguishes the species from *T. carnea*, with which the depressed and rounded shape of the shell very often markedly agrees. Indeed, I am not certain that Davidson's circular variety of *carnea* (loc. cit., pl. viii, figs. 4—5) should not rather be referred to *subrotunda* than to the former species. The simple form of the loop and the strong impressions of the adductors have been described by Schlœnbach (loc. cit.), and it is sufficient to refer here to two figures of the inner views of a hæmal valve, the one having the loop perfectly preserved, the other being an impression with the muscular scars (comp. figs. 11 and 11a, pl. vi).

Three varieties may be distinguished. The first (see figs. 1—6 on pl. vi) has an almost circular or roundly ovate shape, the front is simple or very slightly insinuated. The second (figs. 7—16) has an ovate or elongate shape, and the frontal sinus is usually well marked, or even a biplication is indicated. In both these forms, which gradually pass into each other, the beak has a moderate size.

Locality.—These two varieties which represent true *subrotunda* occur in very large numbers in the greyish, somewhat ferruginous, sandstone south-west of Mulloor (where *T. biplicata* is rare), and north and south of Karapaudy; more rarely south-west of Murvanoor, at Olapaudy and Vylapaudy; all these localities are in the Arrialoor group. From other groups only a single specimen exists in the collection, in a coarse silicious sandstone, and it is stated to be from Kolakonuttom, a locality situated within the boundary of the Trichinopoly group.

The third variety may be noted as *var. subundata;* some of the specimens are identical with the form described by Leymerie as *albensis.* It is a roundly oval or oval shell, often with more convex valves than the last, with a simple broad or almost obsolete sinus in front, and generally with a remarkably small, sometimes almost minute beak (comp. figs. 17—23, pl. vi).

Locality.—This variety chiefly occurs in the Trichinopoly beds; it is very common in the ferruginous earthy rock at Shalanure and also at Andoor and between Andoor and Veraghoor; only a few specimens are from Vitagoody (east of Veraghoor), situated within the geographical extent of the Arrialoor group.

Formations.—Trichinopoly and Arrialoor groups.

In Europe (England, Germany and France) *T. subrotunda* occurs in strata immediately above the *Rotomagensis* beds (exactly as in India), extending to the lower Senonien. Davidson quotes it also from the Red Chalk (?= Gault), but this occurrence is somewhat doubtful, and so is also that in the uppermost cretaceous beds of Rügen and in Sweden.

7. TEREBRATULA CAPILLATA, *d'Archiac*, Pl. VII, Fig. 1.

1842. *Spondylus undulatus*, Geinitz. Characteristic Petræf. Sæchs. Kreideg., p. 82 (ex parte), and 1843, Verst. von Kieslingswalda, pl. vi, fig. 8.
1847. *Terebratula capillata*, d'Archiac, Mém. Soc. Géol. France, 2nd ser., vol. ii, pt. ii, p. 323, pl. xx, figs. 1—3.
1850. *Terebratula capillata*, Geinitz, Quadersandstein-gebirge, p. 212.
1852. *? eadem*, Davidson, Brit. Cret. Brach., p. 46, pl. v, fig. 12.
1868. *eadem*, Schlœnbach, Geog. Palæont. Beitræge, by Benecke, &c., vol. i, p. 454.

Ter. testa ovata seu sub-pentagona, superficie radiatim dense costellata seu striata, costellis ad intervalla striis incrementi abruptis intersectis; valva neurali alterâ paulo convexiore, umbone producto, modice incurvo atque foramine rotundato truncato, area concava; deltidio parvo, medio suturâ indistinctâ diviso; valva hæmali subrotundata, antice in speciminibus adultis medio paulum impressa.

Although only a single neural valve has as yet been found in the South Indian cretaceous deposits, there can, I think, be no reasonable doubt as to the identity of that specimen with the European *T. capillata.* The general subpentagonal form, the convexity of the valve and of its beak, the concave area, the fine costuliform striation, intersected at distances by abrupt striæ of growth, perfectly coincide with the characters of the species, as recorded by d'Archiac and others. In the three specimens figured by d'Archiac, the apical angle is 93, 96, and 103 degrees respectively; in the Indian specimen it is 96 degrees.

Schlœnbach (loc. cit.) mentions that there appears to be some doubt as to whether the two specimens from the Red Chalk (Upper Gault), noticed by Davidson under the name of *T. capillata*, really belong to the latter species. The form of the figured specimen is certainly somewhat too regularly ovate, the umbonal ridges of the neural valve more projecting, and the radiating ribs stronger than in d'Archiac's types, but all these differences may be attributable to local variation, and as Davidson had Tournay specimens for comparison, it is not very probable that he was mistaken in their identity, particularly as he notices the "capilliform[*] elevated striæ" in his description. However, considering provisionally the occurrence of *T. capillata* in the Upper Gault as not definitely settled, the geological horizon of the species falls within the cenomanien, particularly the lower beds of it. It occurs in these strata (Tourtia) in Belgium, near Essen, near Dresden and in various other parts of Germany. This geological position exactly corresponds with that in which we meet with the same species in India.

Locality.—Ootatoor, a single specimen in a yellowish brown limestone.

Formation.—Ootatoor group (the zone of *Am. rostratus* and *Rotomagensis*, *Inoceramus labiatus*, *&c.*).

8. TEREBRATULA OOTATOORENSIS, *Stoliczka*, Pl. VII, Figs. 2—3.

Ter. testa rotundata, fere circulari, modice inflata, sub-lævigata, minutissime punctata et striis incrementi nonnullis sub-rugatis notata; valva neurali alterâ convexiore, medio antice paululum extensa, rostro brevi, incurvo, foramine magno, rotundato truncata; deltidio medio unito, brevissimo sed lato, apicem valvæ hæmalis attingente; lateribus umbonalibus rotundatis, area nulla; valva hæmali leviter convexa, antice margine mediano paulo insinuato.

A very characteristic almost circular robust species, with a finely punctate surface, slight frontal sinus and a small blunt beak, truncated by a large round foramen, very closely placed to the apex of the hæmal valve. The deltidium is united in the middle, very short, but broad, extending laterally into long points. The umbonal sides are rounded or obtuse, forming an angle of about 100 degrees; there is no special area marked.

Locality.—Ootatoor, one of the two figured specimens is from a concretionary earthy limestone, the other from a more compact, pinkish limestone.

Formation.—Ootatoor group.

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[*] The occurrence of similar striæ in *T. depressa* must have been the principal reason for d'Orbigny's uniting the two species, as suggested by Dr. Schlœnbach.

9. Terebratula diphimorpha, *Stoliczka*, Pl. VII, Figs. 4—5.

T. testa sub-trigona, depressiuscula, peripheria incrassate et valde obtusata, concentrice rugosa, radiatim minutissime striata; valva hæmali fere plana, in parte anteriori medio leviter impressa; v. neurali convexiuscula, umbone prominulo, paulo incurvo, foramine patulo truncato; deltidio magno, concavo, medio suturá juncto; lateribus umbonalibus sub-rotundatis seu obtusis, angulum 80°—90° *formantibus.*

This species belongs to the type of *Ter. diphia* and *diphioides*, &c., represented in the highest beds of the jurassic and the lowest of the cretaceous deposits; it differs, however, from those species by the presence of a fine radiating striation. The only other species, I know, of the same type is *Ter. Guiscardiana*, Sequenza, described and figured by Davidson from the Italian tertiary beds (Geol. Magazine, 1870, VII, p. 370, pl. xviii, fig. 9). The Indian cretaceous species is more dilated than the last, and has the beak distinctly, though not very strongly, curved.

Locality.—Moraviatoor, in a concretionary, dark brown, limestone. Only the two figured specimens have been examined.

Formation.—Ootatoor group.

TEREBRATULINA, *D'Orbigny*, 1847.

(Davidson, Classif. Brachiopoda, &c.).

Shell usually longer than wide, punctate, radiately striated or ribbed, neural valve with the beak truncate and perforate at the end, straight or slightly curved, with the deltidium small and divided, or rudimentary, and with the usual hinge-teeth as in other *Terebratulidæ*; hæmal valve smaller, often with a straight hinge margin, produced into an auricle on either side, apophysary apparatus short, scarcely equal to one-third of the length of the shell, formed by two, anteriorly united arms, about the middle of the sides connected by two branches, which remain, however, for some time separate in the young shells. The type of the genus is the recent *T. caput-serpentis* (Linnè). Dall (Am. Jour. Conch., 1870, vol. vi, p. 106) enumerates seven recent species. There are several known from tertiary deposits, but the maximum of development appears to fall in the cretaceous epoch. A nearly complete list of the species from the latter is given by Schlœnbach in Dunker's and H. v. Meyer's Palæontographica, 1866, vol. XIII, pp. 274—275. The oldest species are known from jurassic deposits, one or two from the Lias being doubtful.

1. Terebratulina relicta, *Stoliczka*, Pl. VII, Figs. 6—7.

Ter. testa ovata, longiore quam lata, valva hæmali alterá multo convexiore, auriculis distinctis, crassiusculis instructa, antice paulum insinuata; valva neurali rostro elongato, lente curvato, apice truncato et perforato, lateribus rotundatis, angulum fere 75° *formantibus, medio paulo depressa, margine antico mediano rotundate* *producto sursumque curvato; superficie radiatim multi-costata, costis in v. neur. ad apicem circiter* 15, *simplicibus, deinde regione mediana dichotomis et lateraliter multidivisis, in v. hæm. costis prope apicem circiter* 12, *simplicibus, deinde numerose divisis, et valde attenuatis, omninis minute granulosis et ad intervalla striis incrementi nonnullis abrupte intersectis.*

I have only a single specimen of each valve to examine, but both are sufficient for the determination of this interesting species. It differs from nearly all known cretaceous forms by the hæmal valve being considerably more convex than the neural one, and by the latter having its median anterior margin conspicuously produced and turned upward. In the latter character the species approaches the jurassic *T. substriata*, Schloth.

The radiating ribs are more numerously divided, and consequently thinner, on the hæmal than on the neural valve.

Locality.—North-west of Coodycaud (beds of *Am. Rotomagensis* and *rostratus)*, apparently rare, in a yellowish brown limestone.

Formation.—Ootatoor group.

KINGENA, *Dav.*, 1852.

Davidson, British Cret. Brach., p. 40.

Shell inequivalve, subcircular, elongately subpentagonal or ovate, with the surface more or less distinctly granular and pustulate; neural valve generally with well developed umbonal ridges, and a small deltidium in two pieces, separated or touching each other; hæmal valve with a distinct septum, and the reflected (neural) portion of the arms united and attached to, or intersected by, the septum; muscular impressions similar to those of other *TEREBRATULIDÆ*. Type, *Kingena lima*, Defr., from cretaceous rocks.

There are only a few cretaceous and tertiary species referable to this genus, such as *Tereb. tamarindus*, Sowerby, *Kingena pustulosa*, Bosq., *K. Raincourti*, E. Desl., &c.

Megerlea differs from *Kingena* by the radiating striation or costulation of the shell, and by the neural portion of the brachial system being attached to the septum as well as to the hæmal branches, and also by having the lateral loops filled with shell substance, which latter character separates it from *Ismenia*.

1. KINGENA GRANULIFERA, *Stoliczka*, Pl. VII, Figs. 8—12.

King. testa subpentagona seu elongate ovata, antice et postice sensim producta, superficie densissime æqualiter granulata, valvis modice convexis; valva hæmali antice sensim depressa, postice uniforme subrotundata, septo lineari ¾ partem longitudinis æquante; val. neurali medio maxime elevata, lateraliter depressa; umbone valde *prominulo, paulum incurvo, carinis umbonalibus acutissimis aream in utroque latere longam et fere planam marginantibus; foramine magno; deltidio medio distincte diviso.*

A subpentagonal or elongately ovate shell, with the two valves almost equally strongly convex. The surface is covered with fine, equal, and very densely set granules, when well preserved; but when it is a little worn off, the granulations appear to be arranged in finely undulating rows. The hæmal valve is anteriorly somewhat depressed, posteriorly rounded; the septum equals in length about $\frac{3}{4}$ of that of the shell. Of the brachial apparatus I could trace only fragments on different sections of the valve, but it could be seen that it closely resembles that of *Kingena lima*, the neural reflected portion being very broad and meeting the septum under a rather small angle.

The hæmal valve is most convex along the middle of its entire length, and is laterally considerably depressed. The beak is slightly incurved, with a large dilated rounded foramen in front. The deltidium is always in two pieces, each of which is elongately triangular. The beak ridges are very strongly developed and sharp, peculiarly bent upwards as they approach the foramen, the consequence being that the beak appears to be very truncate; while, if the lower portion of the ridges were regularly prolonged, they would meet at the beak under an angle of about 95 degrees.

K. granulifera is readily distinguished from *K. lima* by the anterior median depression of the hæmal valve, more prominent and less incurved beak, and by stronger umbonal ridges. The general form itself comes nearest to the varieties of *K. lima*, figured by Deslongchamps in Bull. Soc. Norm., 1861-62, vol. vii, pl. viii, and also by Schlœnbach in Sitzb. Akad., Wien, vol. lviii, p. 212, pl. iii, figs. 1—2, but it separates it equally readily from *King. tamarindus*, which has the deltidium generally united in the median line. As regards the shape of the beak and the dense granulation, *K. granulifera* is probably more closely allied to the tertiary *K. Raincourti*, than to any of the cretaceous species (Deslongchamps in Bull. Soc. Norm., vii, p. 294, pl. viii, figs. 12—14).

Locality.—Olapaudy, in a ferruginous oolitic rock; seven specimens have been examined.

Formation.—Arrialoor group.

2. KINGENA LIMA, *Defrance*, Pl. VII, Fig. 13.

Kingena lima, Defr., Davidson, Brit. Cret. Brach., 1852, p. 42 (cum. syn.).
Megerlea lima apud Schlœnbach, Benecke's Geogn. Palæon. Beiträge, 1868, i, p. 469 (cum. syn.).

The only specimen in our collection from Southern India is a very imperfect one, but the comparison of numerous European specimens makes, I think, the identification certain. The form is roundly ovate, the hæmal valve less convex than the neural one, the former being in the middle of the front slightly depressed;

the beak ridges are sharp, and the deltidium divided in the middle; a few fragments of the surface of the shell show distinctly a fine unequal granulation. As regards shape the specimen perfectly resembles the form figured by Schlœnbach in Sitzgsb. Math. Nat. Klasse Akad., Wien, vol. lvii, p. 222, pl. iii, fig. 1.

Locality.—Comarapolliam, in soft conglomeratic sandstone.

Formation.—Arrialoor group.

The principal layers of *Kingena lima* in Europe are the upper and middle cretaceous beds, Chalk and Upper Greensand (Oberer and Unterer Plæner of German Geologists; Senonien, Turonien and Cenomanien of D'Orbigny). Schlœnbach says that it is very abundant in the Tourtia (zone of *Trigonia sulcataria)* of Northern Germany, and in a great many other Cenomanien localities. It is also common in the Maastricht beds, in the upper cretaceous beds near Lemberg, (Galizia), &c. The same author is also of opinion that the Texas species, *Ter. Wacoensis*, Römer, is probably identical with *K. lima*.

From the Gault at Folkstone, &c., there are fewer specimens known, but they are, according to Davidson, not distinguishable from the upper cretaceous type, although Deslongchamps attempted to separate several species according to different geological horizons.

3. KINGENA ASPERULINA, *Stoliczka*, Pl. VII, Fig. 14.

Ter. testa pentagone subrotundata, depresse globosa, ad umbonem contracta; valva neurali alterâ paulum convexiore; superficie uniforme minuteque spinulose granulifera, peripheriam versus striis incrementi nonnullis subrugosis notata; valva hæmali antice late vix insinuata, septo brevi instructa; umbone modice prominulo, valde incurvo, foramine latinsculo truncato; deltidio brevi, late expanso, medio sutura simplici tenuissima diviso, carinis umbonalibus acutis, aream angustam, lævigatam, fere planam, in utroque latere marginantibus.

The regular almost round form and great convexity of the valves, with a fine equal, but not very dense spinulose granulation on the surface, are very prominent characters, which distinguish the present species from the others known of the genus.

The hæmal valve is slightly less convex than the neural one, and has a short septum perceptible in about ⅓rd the length of the valve. The foramen is large and somewhat transversely dilated. The beak ridges are very sharp, and enclose on either side a rather flattened, nearly smooth, and narrow area. The deltidium is in two pieces, very short, forming a very small suture in the middle, but it is much wider than in any known specimens of *Kingena lima*, from which it also differs by the shortness of the septum and the large foramen, &c.

Locality.—North-west of Coodycaud, in a pinkish limestone; only the figured specimen has been obtained.

Formation.—Ootatoor group.

4. Kingena shalanurensis, *Stoliczka*, Pl. VII, Figs. 15, 16, 17.

King. testa rotundate vel oblonge ovata, valva umbonali altera convexiore, superficie minutissime æqualiter granulata; valva hæmali medio paululum insinuata, septo $\frac{2}{3}$ *longitudinis æquante instructa; valva neurali postice valde angustata, angulum circiter* 85°—90° *formante, carinis umbonalibus distinctis, acutis; umbone valde incurvo, longo, foramine rotundato truncato; deltidio parvo, prope foramen distincter separato, deinde partibus angulatis inter se fere attingentibus.*

Some of the rounder specimens of this species closely resemble the large Cenomanien variety figured by Schlœnbach (Benecke's Geog., Palæont. Beitræge, 1868, vol. i, p. 469, pl. xxii, fig. 8,) under the name of *Kingena lima*, but they are readily distinguished by the greater posterior narrowness of the umbonal valve and strongly incurved and produced beak. The beak ridges are rather sharp and short, but the septum is much longer than usually seen in *King. lima*. The surface is equally and very finely granular, and even on a broken surface of the shell, the punctation is much finer than in considerably smaller specimens of the former species.

Much closer is the resemblance of our species with Meyer's Lower Greensand *Waldheimia Morrisi* (Geol. Mag., v, 1868, p. 269, and *ibid.*, vol. i, pl. xii, figs. 12—14), but the beak is in this last much less incurved and the deltidium much more exposed, larger, the two pieces forming a distinct suture; the septum also is said to be short. Similar characters equally easily separate our species from *Waldh. longa*, but as regards form and the curvature of the beak, it most closely resembles d'Archiac's *Ter. Robertoni*, and as this species has occasionally been referred to *Waldheimia*, it is possible that those were specimens which belong to the present new species, and that its occurrence in Cenomanien beds of Europe may yet be proved.

Locality.—Shalanure, in a brownish somewhat ferruginous sandstone; five specimens were examined. The largest is 31 mm. long, 24 broad, and about 16 mm. thick.

Formation.—Base of the Trichinopoly group, probably passing into the Ootatoor beds.

General results obtained from the examination of the South Indian Cretaceous Brachiopoda.

From the foregoing descriptions it will be seen that the Brachiopoda equal only about one-twelfth part of the number by which the Gastropoda or Pelecypoda are represented in the South Indian cretaceous rocks. Altogether, I have been able to distinguish only 21 species,* which belong to five genera and three different families, namely, the *Craniidæ* with one species of *Crania*, the *Rhynchonellidæ* with six species of *Rhynchonella*, the TEREBRATULIDÆ with nine species of *Terebratula*, one of *Terebratulina*, and four of *Kingena*. Of the species themselves there are only three, *Rhyn. plicatiloides*, *Ter. sub-depressa* and *sub-rotunda*, which are met with at many of the localities and in a large number of specimens; all the others are rarer, and some only represented by solitary specimens. The uppermost of the three geological divisions, which have been distinguished, contains the largest number of specimens and nearly also that of species; next comes the lower and then the middle division, as will be seen from the accompanying table :—

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* Forbes, when describing the South Indian fossils in 1846, knew only *Ter. depressa*, which he described under the name *T. arabilis*.

NAME.	Page.	Plate.	Figure.	LOCALITIES.	FORMATION (GROUP) IN SOUTHERN INDIA.			FORMATION IN EUROPE, AND REMARKS.
					Ootatoor.	Trichinopoly.	Arrialoor.	
CRANIA—								
1. „ *Ignabergensis*, (Retz.) ...	7	I	1-2	Olapaudy			×	Senonien and Danien of the greater part of Europe.
RHYNCHONELLA—								
2. „ *mutus*, Stol. ...	9	I	3-4	Sirgumpore	×			Resembles *R. pinguis*.
3. „ *Arrialoorensis*, Stol. ...	10	I	5-6	S. E. of Arrialoor ...			×	„ *R. Mantelliana*.
4. „ *compressa*, (Lam.) ...	11	I	7	W. of Andoor		×		Upper Cenom. and Turonien of France and Germany.
5. „ *crenifera*, Stol. ...	13	I	8-10	S. E. of Arrialoor and S. W. of Mulloor.			×	
6. „ *nutans*, Stol. ...	12	I	11-13	S. by W. of Mulloor			×	Resembles *R. Cuvieri*.
7. „ *plicatiloides*, Stol. ...	13	I II	14-28 1-6	Shalanure, Andoor, S. W. Veraghoor, Kullay, Kolature, Kolakonuttom, Ootacoil, Olapaudy, Comarapolliam, Shillagoody, &c.		×	×	
TEREBRATULA—								
8. „ *depressa*, Lam. ...	16	II	7-8	N. of Odium	×		×	(? Lower and) Upper Greensand of England. Cenomanien in France and Germany.
9 „ *sub-depressa*, Stol. ..	16	II III	9-16 1-8	Arrialoor, Poodoopolliam, Valloor, Ootacoil, &c.				
10. „ *conf. Carteri*, Davd. ...	18	IV	1	E. of Olapaudy			×	Turon. and Senon.
11. „ *biplicata*, Sow. ...	19	IV	2-4 & 10-13	S. E. of Mulloor, &c.			×	(? Gault). Upper Greensand and Lower Chalk of England, Cenom and Turon.; Unt. and Oberer Pläner.
11a. „ „ *var. Karapaudiensis*	20	IV	5-9	Karapaudy			×	
11b. „ „ *var. Dutempleana* ...	20	IV V	14-17 1-3	Between Andoor and Veraghoor		×		
12. „ *obesa*, Sow. ..	21	V	4-5	E. of Ootatoor	×			Upper Greensand and Chalk, Cenom and Turon.
13. „ *subrotunda*, Sow. ...	23	VI	1-16	Mulloor, Karapaudy, Murvanore, Olapaudy, &c.			×	Turon. and Senon. beds of England, France, Germany, Sweden, &c.
13a. „ „ *var. subundata* ...	23	VI	17-20	Shalanure, Andoor, Veraghoor, Valtagoody		×	×	
14. „ *capillata*, d'Arch. ...	23	VII	1	Ootatoor	×			Cenomanien of England, France, and Germany.
15. „ *Ootatoorensis*, Stol. ..	24	VII	2-3	Ootatoor	×			
16. „ *diphimorpha*, Stol. ...	25	VII	4-5	Moravatoor	×			
TEREBRATULINA—								
17. „ *relicta*, Stol. ...	25	VII	6-7	Coodyeaud	×			
KINGENA—								
18. „ *granulifera*, Stol. ...	26	VII	8-12	Olapaudy			×	
19. „ *lima*, Defr. ...	27	VII	13	N. W. of Coodyeaud	×			Cenom., Turon., and Senon. of England, France, Germany, &c. (? Gault).
20. „ *asperulina*, Stol. ...	28	VII	14	Comarapolliam...			×	
21. „ *Shalanurensis*, Stol. ...	29	VII	15-17	Shalanure		×		Allied to *T. Robertoni*, d'Arch.

A glance at the preceding list will show the geological distribution of the species. Of the 21 species 9 have been identified with those from European cretaceous deposits elsewhere, giving a percentage of 43, this being much larger than that recorded in any of the three other classes of Mollusca. In the Cephalopoda the percentage of European species was about 24, and in the Gastropoda and Pelecypoda between 12 and 15. The larger number in the case of the Brachiopoda is perhaps principally due to the better and more detailed knowledge we possess of this class.

As regards the distribution of the species in the different groups of Southern India, the table will show, that eight of them are peculiar to the lowest division, the Ootatoor group (zone of *Am. Rotomagensis* and *rostratus*). Of these three species are identical with European ones, *T. depressa*, *obesa* and *capillata*, all occurring in the Cenomanien, and partly also in the Chalk.

To the middle, or Trichinopoly, group two species are peculiar; of these *Rhyn. depressa* occurs in Europe in Cenomanien and Turonien beds.

To the highest, or Arrialoor, group eight species are peculiar, of which again three are European, *Crania Ignabergensis*, *Ter. Carteri*, and *Kingena lima;* the first and second occur in Turonien and Senonien beds; the last makes its appearance already in the Cenomanien, if not in the upper Gault, and continues into the uppermost beds of the cretaceous deposits. The lower and middle divisions have no species common, but the middle and upper have three common, and of these *T. biplicata* and *sub-rotunda* are two of the most common and most widely spread species in European cretaceous rocks. The former certainly begins already in the lower Cenomanien, possibly in the upper Gault, and disappears in the upper beds of the Senonien, while the latter occurs first sparingly in the upper Cenomanien, and is common in Turonien and lower Senonien beds.

Thus, the examination of the Brachiopoda, though comparatively few in number, entirely confirms the results obtained from the other classes of the Mollusca, namely, that our lowest, or Ootatoor, beds very closely correspond to the upper Greensand of English–, Cenomanien of French–, Tourtia and Lower Plæner of German-Geologists, while the Trichinopoly beds answer closely to the Turonien, and the Arrialoor beds to the Senonien. I am convinced that a still more close parallel of the Indian with the European middle and upper cretaceous divisions might be obtained, if the different horizons of the former were better studied on the basis of correctly determined fossils.

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[The species marked with an (*) asterisk occur in South India.]

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PLATE I.

Figs. 1—2. Crania Ignabergensis, *Retzius*, p. 7; figs. 1, 1*a*, 1*b*, upper–, side–, and lower, views of a perfect specimen, natural size; 1*c*, upper view of hæmal valve, twice the natural size; 2, inner view of an imperfect neural valve, natural size; *Olapandy; Arrialoor group.*

Figs. 3—4. Rhynchonella mutua, *Stoliczka*, p. 9; figs. 3, 3*a*, 3*b*, 3*c*, hæmal–, front–, neural–, and side–, views of a cast specimen; 4, neural valve of a larger specimen with the shell surface preserved; *Sirgumpore*; *Ootatoor group.*

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Geol. Surv. of India CRETACEOUS ROCKS S. INDIA. Brachiopoda. *Pl. I*

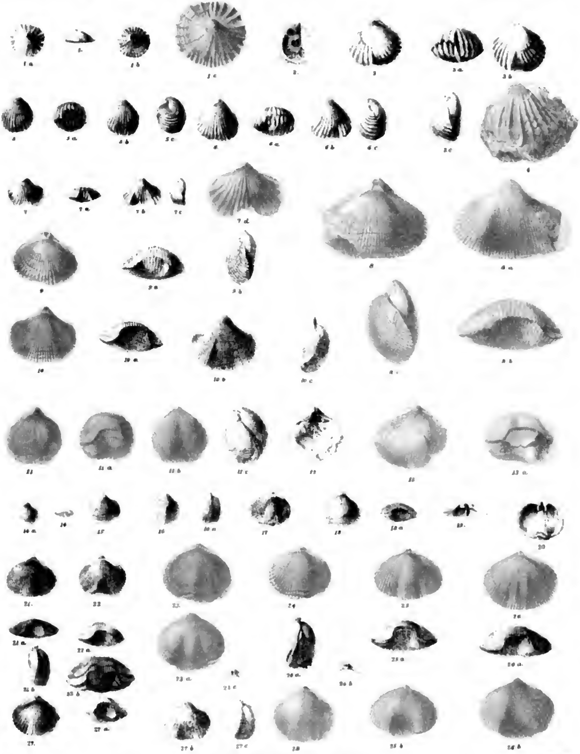

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PLATE II.

Figs. 1—6. RHYNCHONELLA PLICATILOIDES, *Stoliczka*, p. 13. Different views of more or less full grown, transversely ovate or inflated specimens, and with the front margin of the neural valve more or less reflected upwards; figs. 1, 2 and 5 are from *Shalanure ;* fig. 6 from near *Andoor,* in *Trichinopoly group ;* figs. 3 and 4 from near *Ootacoil* in *Arrialoor group.*

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Geol. Surv. of India CRETACEOUS ROCKS S. INDIA Brachiopoda Pl. II

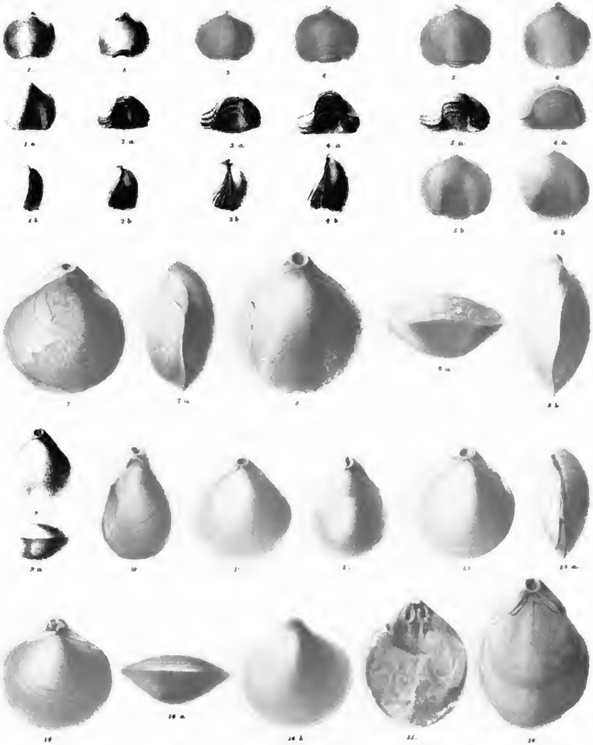

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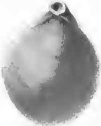
PLATE III.

Figs. 1—8. TEREBRATULA SUB-DEPRESSA, *Stoliczka*, p. 16. Specimens of various sizes and of slightly different growth, mostly all perfectly well preserved; figs. 1, 6, 7, 8 are from north of *Poodoopolliam*, fig. 2 from *Arrialoor*, figs. 3 and 4 from *Vailoor*, fig. 5 from near *Chokonadapooram*; all from the *Arrialoor group*.

Geol. Surv. of India CRETACEOUS ROCKS S. INDIA Brachiopoda *Pl. III.*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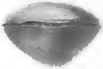
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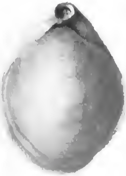
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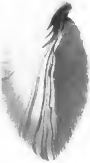
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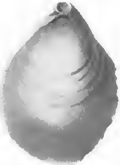
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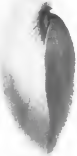
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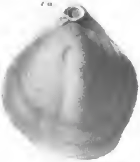
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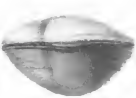
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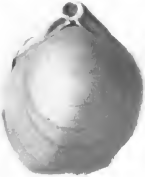
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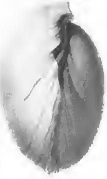
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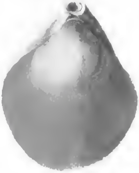
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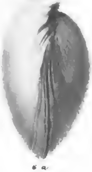
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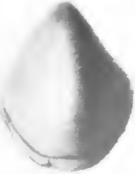
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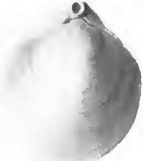
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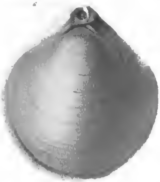
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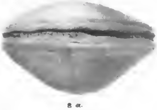
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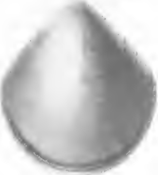
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PLATE IV.

Fig. ... 1. TEREBRATULA *conf.* CARTERI, *Davidson*, p. 18; a specimen with the beak of the neural valve somewhat imperfect; *East of Olapaudy; Arrialoor group.*

Figs. 2—17. TEREBRATULA BIPLICATA, *Sowerby*, p. 19.

Figs. 2-4 and 10-13 represent the most typical form with a thick, conspicuously incurved beak; all the specimens are from the neighbourhood of *Mulloor, Arrialoor group;* in fig. 10 the biplication is scarcely traceable, in 11 it is slightly indicated, in 12 it is slight, but distinct, in the remaining four specimens it is well marked.

Figs. 5-9 represent the variety named *Karapaudiensis*, p. 20, distinguished by an elongated form and a thinner beak; in fig. 9 the biplication is absent, in fig. 7 scarcely indicated, in figs. 5 and 8 distinct; fig. 6 is the inner view of a portion of hæmal valve; all specimens are from near *Karapaudy; Arrialoor group.*

Figs. 14-17 represent the variety *Dutempleana* (see p. 20); in fig. 15 the biplication is not marked, in 16 it is very slight, in 17 very strong, but comparatively less so in the large specimen represented in fig. 14; this shows that the amount of biplication is independent of size and age; the last specimen is from *Olapaudy, Arrialoor* group; the other specimens from between *Andoor* and *Veraghoor* in *Trichinopoly group.*

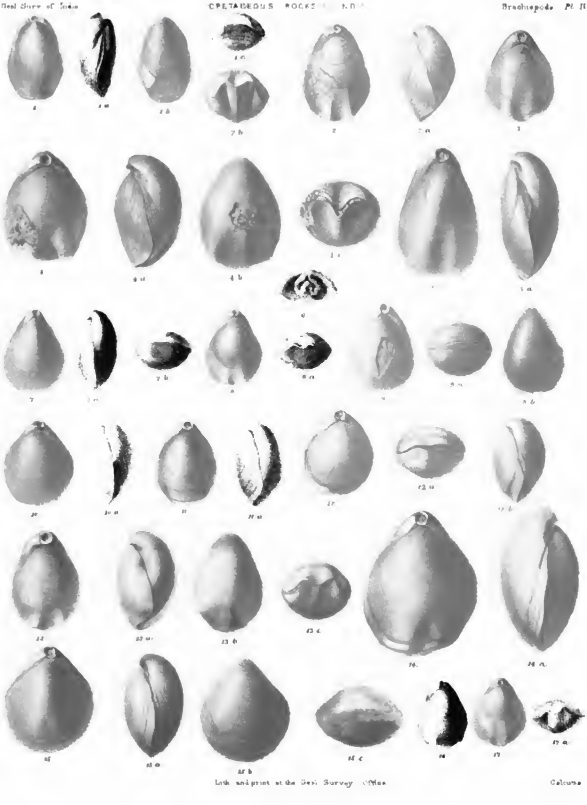

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PLATE V.

Figs. 1—3. Terebratula biplicata, var. *Dutempleana, d'Orb.*, (see p. 20); adult specimens with slight traces of radiating striation; between *Andoor* and *Veraghoor; Trichinopoly group.*

Figs. 4—5. Terebratula obesa, *Sowerby*, p. 21. Two adult specimens, one moderately, the other strongly inflated; *East of Ootatoor* in gypseous shales; *Ootatoor group.*

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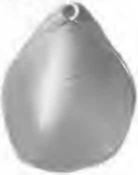
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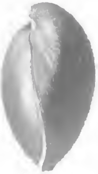
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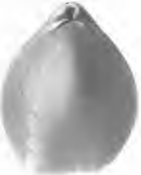
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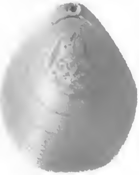
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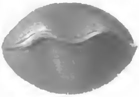
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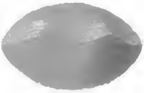
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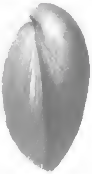
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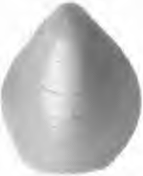
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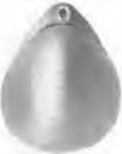
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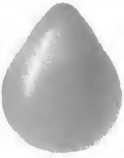
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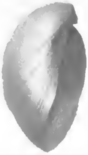
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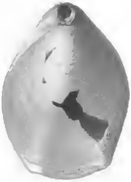
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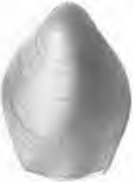
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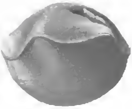
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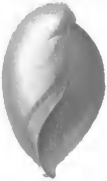
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PLATE VI.

Figs. 1—23. TEREBRATULA SUBROTUNDA, *Sowerby*, p. 22.

Figs. 1-6 represent specimens in different stages of age of the rounded variety, with a moderately large aperture of the beak and almost entire absence of a frontal sinus; fig. 5 is from *East of Andoor*, and the other five specimens from near *Karapaudy, Arrialoor group.*

Figs. 7-16 represent more ovate shells, in most of which a slight frontal biplication of the margins is indicated; the aperture of the beak is of the same size as in the round variety; fig. 7 is from near Karapaudy; fig. 11, which represents the brachial apparatus, and 11*a*, the impressions of the muscular scars of the hæmal valve, are taken from a *Veraghoor* specimen; the other larger specimens are all from *S. W. of Mulloor; Arrialoor group.*

Figs. 17-23 represent specimens of the variety *subundata*, most of them having a remarkably small opening in the beak of the neural valve; 17 is an abnormal specimen of a transversely ovate shape, the front having at one time evidently been injured; from *S. E. of Karapaudy, Arrialoor group.* Fig. 18 shows the normal form of the small beak, and, like fig. 19, is from *Shalanure;* the remaining figures are taken from specimens found between *Andoor* and *Veraghoor; Trichinopoly group.*

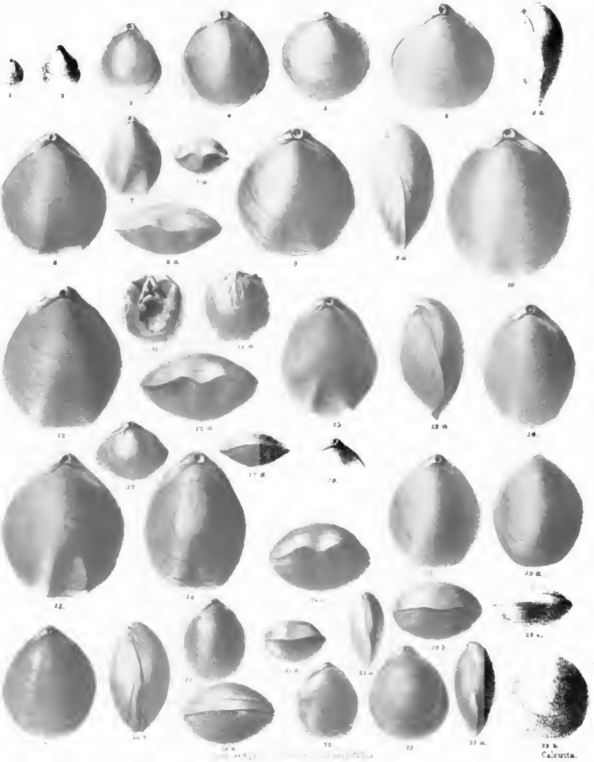
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PLATE VII.

Fig. ... 1. TEREBRATULA CAPILLATA, *d'Archiac*, p. 23. A single neural valve, with the surface of the shell partially preserved; *Ootatoor; Ootatoor group.*

Figs. 2—3. TEREBRATULA OOTATOORENSIS, *Stoliczka*, p. 24. Two somewhat imperfect adult specimens; the original shell surface is only partially visible; *Ootatoor; Ootatoor group.*

Figs. 4—5. TEREBRATULA DIPHIMORPHA, *Stoliczka*, p. 25. In the smaller specimen the striated shell surface is well preserved; in the other the peculiar broadly terminating beak of the neural valve is seen; *Moraviatoor; Ootatoor group.*

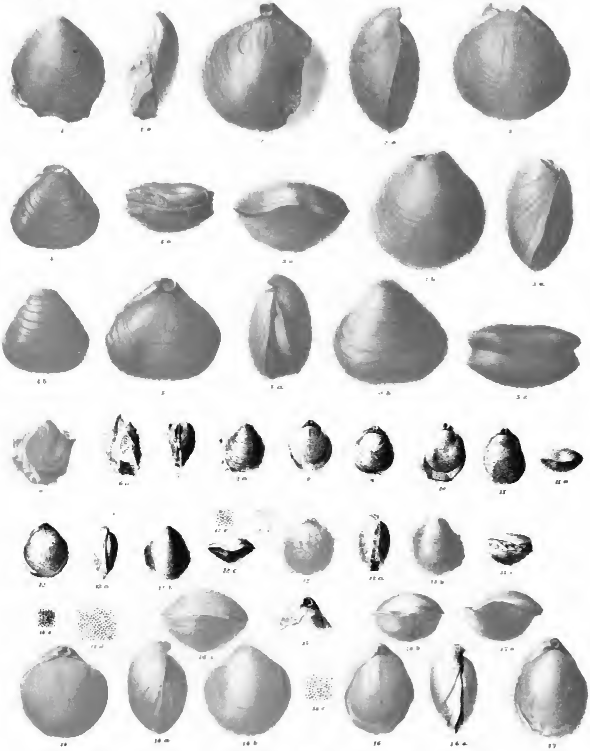
Figs. 6—7. TEREBRATULINA RELICTA, *Stoliczka*, p. 25; 6 is the neural and 7 the slightly less coarsely striated hæmal valve; *N. W. of Coodycaud; Ootatoor group.*

Figs. 8—12. KINGENA GRANULIFERA, *Stoliczka*, p. 26. The figures exhibit the slight variations in the shape of the shell; *Olapaudy; Arrialoor group.*

Fig. ... 13. KINGENA LIMA, *Defrance*, p. 27. A very imperfect specimen, with only small fragments of the shell preserved; *Comarapolliam; Arrialoor group.*

Fig. ... 14. KINGENA ASPERULINA, *Stoliczka*, p. 28. The figure shows a perfectly well preserved specimen; 14*e* exhibits the original finely spinulose surface, and 14*d* the same after the uppermost layer of the shell had been removed; the spinules are then replaced by little pits in the surface; *North-west of Coodycaud; Ootatoor group.*

Figs. 15—17. KINGENA SHALANURENSIS, *Stoliczka*, p. 29. Fig. 15, a portion of a shell with well preserved beak; both the other specimens are slightly forced out of the regularly ovate shape by lateral pressure; fig. 16 shows the impression of the long septum of the hæmal valve; *Shalanure; ? Trichinopoly group.*



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MEMOIRS
OF THE
GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL,
UNDER THE DIRECTION OF
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Hon. Mem. of Leop-Caroline Academy of Natural Sciences: of the Isis, Dresden: of the
Roy. Geol. Soc., Cornwall: Corr. Mem., Zool. Soc., London, &c., &c.,
SUPERINTENDENT OF THE GEOLOGICAL SURVEY OF INDIA.

CRETACEOUS FAUNA OF SOUTHERN INDIA.

Vol. IV. 2.

Ser. Viii. 2. The CILIOPODA, by Ferd. STOLICZKA, Ph. D., F. G. S., &c., &c.,

Palæontologist, Geological Survey of India.

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INTRODUCTION.

The Ciliopoda are comparatively the least numerous of all the Mollusca which have been treated of, and their occurrence is also limited to a single group, the Arrialoor; therefore, the bearing of the class upon the determination of the relations of the cretaceous beds is not a very important one. I shall, however, say a few words on this subject at the end of the detailed descriptions of the various species.

As regards the treatment of the class, I confine my remarks to a notice of those genera which are represented in the South Indian cretaceous deposits, and to a few others closely allied to them. I do not need to repeat the complaints regarding the great and well known deficiencies in the present systematic arrangement of the class, and although I have for many years past devoted considerable attention to the study of recent and fossil Ciliopoda, and should have much wished to give a somewhat similar review of, at least, the marine genera of this class as that given of the Pelecypoda, the present opportunity is not suitable for the purpose. The task is indeed a very great one, and would involve a large amount of time and labour, while the illustrations, which could be supplied from the Indian cretaceous species, would in no way be sufficient.

The name with which I have denoted the class on the title may call for an explanation, though this can scarcely be more than a repetition of what I have repeatedly stated on other occasions. Already in my introduction to the South Indian Cretaceous Gastropoda, I suggested the substitution of the name Ciliopoda for Polyzoa or Bryozoa, and that of Saccopoda for the Tunicata.

In the introduction to the Pelecypoda, I again stated that, if uniformity in the denominations of the different classes of the Mollusca is to be attained,—and few will deny its desirability—the locomotive organs appear to be more suited for that purpose than the organs of respiration, or the system of cephalisation, which in some cases yields merely negative characters. It seemed to me, therefore, most practicable to conform the names of the two lowest classes of the Mollusca to those of the rest, which are almost generally adopted. There is nothing objectionable in the combinations of the names, if we merely associate with the word ποῦς-ποδος a signification referring to an organ which facilitates locomotion. In the Tunicata, strictly speaking, the whole mantle-sac acts as an organ of locomotion, and, therefore, the name Saccopoda seems to me quite as much admissible as that of

Tunicata. In the so-called Bryozoa or Polyzoa the only motion of the body possible is that through cilia of various lengths, and this suggested the name Ciliopoda. I am perfectly aware of the great disadvantage of coining characteristic names from the consideration of a single organ in a large division of the animal kingdom, such as the Mollusca represent, but no system will ever enjoy advantages without consoling itself with at least some disadvantages. And if we really look upon the names of the other classes now in general use, I do not think that of Ciliopoda in any way less correct or less suggestive than that of Brachiopoda or Cephalopoda.

Still the question may be put, whether it is at all desirable at the present stage of our knowledge to introduce a new name for a class of which Zoologists are in doubt whether it belongs to Molluscs or to Worms. Doubts of that kind may and will arise, the more our detailed knowledge of the structure and development of the various groups of animals increases, but the difference in, or deviation from, the general type may be weighed very differently by some authors than by others, according to their ideas of the absolute distinction of the divisions of the animal kingdom, or of the gradual transition from one to the other. I cannot see any conclusive reason for Mr. Morse's assertion that the Ciliopods, as well as the Brachiopods, ought to be removed from the Mollusca, and classed with the Vermes. The question regarding the Brachiopods was lately discussed at length by Dall in the American Journal of Conchology, vol. 7, p. 39; and much that has been said regarding the latter class applies equally to the Ciliopods and Saccopods. Indeed, from some recent observations of Prof. Allman* on the anatomy of a new Ciliopod genus, *Rhabdopleura*, it appears that some Ciliopoda, at least, are morphologically even more closely related to the Pelecypoda than to the Brachiopoda. I do not for one moment wish to deny the importance of embryological studies as bearing upon our zoological system, but it must be borne in mind that our classification refers, in the first instance, to the full grown and well developed animal, not to the embryos or to abnormities, or occasional deviations from the type. Supposing we took the embryos of man, of a tiger, a bird, a turtle, and a lizard, and wished to arrange our classification according to their relations and differences, what would become of our system of the Vertebrata!

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* Quart. Jour. Mic. Sc., New Ser., No. 33, 1869, p. 62.

Sub-kingdom, MOLLUSCA.

Class, CILIOPODA, (= *Polyzoa* = *Bryozoa*).

CHARACTER.—*Acephalous Mollusca, consisting of a simple mantle-sac, only open on the anterior side, enclosing all the other organs, which are entirely or mostly retractile within the sac, its margin being more or less thickened, or sometimes produced into arms, but in all cases provided with a row of finely ciliated tentacles; within these the mouth is situated, on the dorsal side of which terminates the anus. A single ganglion lies between the mouth and the anus. The animals are hermaphrodites, but the propagation also consists in a repeating gemmation, on account of which they form more or less extensive, partially free-growing or entirely attached colonies, composed of variously shaped, horny, or chitinous or calcareous, cells or tubes which are secreted by the animals; they are all aquatic.*

This characteristic is a very general one, but it is common to all known Ciliopods, and suffices to distinguish them readily from all the other classes of Mollusca. In the way of an explanation I shall add a few details regarding their organisation; these must necessarily be brief and only refer to the principal organs. It is, at the present stage of our knowledge, extremely difficult to supply a satisfactory general account of the class, because the only good anatomical descriptions we possess chiefly refer to the fresh water forms, as known from the able researches of Dumortier and van Beneden, Allman, Hyatt, and others, while of the marine Ciliopoda a comparatively very small number of animals has been examined by various authors. As it is, however, the object of the following pages to give an idea of the organisation of the latter group, I will confine my remarks chiefly to those characters which are, from more or less detailed observation, known to be common to both.

The body represents a simple, either cylindrical or bottle-shaped sac, which is open and free on one side, and on the opposite connected by a thin cord with the previous cell, from which the former sprang up by gemmation. The sac or cell consists of two structures, the so-called ectocyst and the endocyst, each of which is again composed of several layers of cells and muscular fibres, the endocyst having, according to Hyatt, five such different layers. The ectocyst secretes either horny or chitinous particles in the fleshy soft mass, or a regular continuous membrane of those substances, or else a calcareous crust, which defines the external shape of each cell, communicating by one or several canals with the neighbouring cells. The calcareous ectocyst is, however, not secreted in distinct superposing layers, but in single fibres, which are placed vertically to the body, and are traversed by numerous canals, terminating on the outer surface as so many larger and smaller pores.

The anterior portion of the sac is revertible in itself; its margin is supplied with a row of tentacles, in some of the fresh-water forms arranged on special, generally horse-shoe-shaped, thickenings, called the lophophor. These tentacles are externally provided with rows of vibratile cilia, the chief function of which is probably to produce a current of water, directed towards the centre of the tentacles, between which the mouth is situated. Whether the tentacles really act as branchiæ is not fully ascertained. They are hollow, and the fluid which fills the body is said to have been observed to pass up and downwards in them. It yet, however, remains to be proved whether this is a true system of circulation of the animal fluid or of the blood. No special blood, or vasculary-vessels exist, but the fluid which fills the body is kept in constant motion by the cilia lining the entire inner surface of the endocyst. I have on several occasions observed this current within the body in some of the fresh-water Ciliopods, which did not protrude their tentacles for several days, and from this fact I would be inclined to give the latter only a secondary importance in the system of respiration. It is not known in what way water finds access to the internal body, whether through the mouth, or in consequence of the capillarity of the entire endo- and ecto-cyst, both of which are traversed by numerous canals; certainly some such function must be attributed to the latter.

The digestive organs consist of the mouth, the œsophagus and the alimentary canal, which widens before the middle of its length into the stomach and then bends dorsally, gradually becoming thinner and terminating near the mouth at the outer or inner edge of the tentacular ring. Certain valves and appendages have been observed in the œsophagus of some of the marine Ciliopods, and in the fresh-water forms a valve also exists at the entrance of the stomach. The food has been seen to move up and down in the stomach with the greatest rapidity before it entered the intestine, and the absorption of the nutriment appears to take place through both the stomachic and the intestinal membranes, through which it passes into the inner space of the body, and unites with the fluid which fills the latter. There are no special organs of manducation, and the only secretionary organ, which was observed in a few species, consists of a thin layer round a portion or the whole of the stomach, and is composed of cells filled with a yellowish-brown substance; this organ appears to represent the liver, and has a situation similar to that in all the other classes of Mollusca. Besides the tentacles, which often act as prehensile organs, there are in the Cheilostomata group of the marine Ciliopods special organs serving apparently the same purpose; these are the so-called vibracula and avicularia. The former are simple long threads, often annulated; the latter resemble the head of a bird with the two mandibles, and act prehensilely in exactly the same manner. Both generally secrete special tubes or small cavities distinct from the ordinary cells.

The muscular system has a great number of longitudinal and transverse muscles; the latter are sometimes arranged in circular bands on the endocyst. Of other muscles the principal ones are those which make the invagination of the anterior part of the body with the alimentary canal possible; they consist of two principal bundles attached near the oral margin and at the base of the cell. Beside that there are special muscles for the contraction of the mouth and of the œsophagus; rotatory muscles for regulating the movements of the tentacles, &c.

Both longitudinal and transverse muscular striation has been observed in the Ciliopods.

The centre of the nervous system is a small ganglion, or a pair of ganglia, situated on the dorsal side of the œsophagus, as in other Mollusca. From it proceed branches to the base of the tentacles and to the other parts of the body. They have been studied with very great detail by Hyatt in the Phylactolæmata, and have received different names according to the parts of the body which they supply. (Comp. Proceed. Essex Institute, vol. v, p. 104 and seq.). There are no special organs of sensation, but the soft parts of the body are sensible both to touch and the influence of light. The tentacles particularly appear among other parts to represent the organ of touch.

Propagation takes place either by buds or by ova. The former are of two kinds, external or internal. The first has as its object the enlargement of the colony. It begins with a slight protuberance of the ectocyst, filled with a granular mass, which soon separates the endocyst, in which gradually the young Ciliopod is developed, resembling in form and structure the mother cell. The internal budding consists in the formation of the so-called statoblasts, rounded or ovate, and more or less compressed, bodies which are formed at or near the base of the endocyst, and often are provided with separate hook-like appendages on their edges. Generally a number of statoblasts is found attached to the funicula in different stages of development. The propagation by statoblasts is of common occurrence in the fresh water Ciliopods, but it has not equally satisfactorily been observed in the marine forms. The development of the young from the statoblast is somewhat similar to that from the ovum. The animals are, as far as known, hermaphrodites, but the ovarium and the testicle are attached separately to different portions of the endocyst. The development from the ovum begins by a separation of the yolk mass from the ectocyst, until the young Ciliopod resemble a single sac, closed on one end and widely open on the other, and surrounded with a row of cilia at its margin; the embryo is then perfectly free, swimming about, and either this, or the stato-blast stage, is the only independent locomotion we know in the Ciliopod individual. After a time the embryo becomes fixed to some foreign object, and then the usual increase of the colony by external budding goes on. In some fresh water forms, as in *Cristatella*, the colony retains its flexibility and the power of slightly changing its place, but, in by far the greater number of species, the colony is permanently fixed.

Premising these few general remarks on the organisation of the Ciliopods as a class, I will just allude to the principal divisions which have been distinguished, and briefly notice the distribution in time and space of those groups with which we are here more particularly concerned.

The primary division of the class is, according to the arrangement of the tentacles, in a single ring at the edge of the anterior end of the cell, or situated on special horse-shoe–shaped arms; the former constitute the *Gymnolæmata*, and are mostly marine; the latter, the *Phylactolæmata*, all of which are fresh water inhabitants.

The former sub-class is separated into 1*st*, the *Paludicellæa*, which possess an imperfect evagination of the tentacular sheath, and are all fresh water forms; 2*nd*, the *Cheilostomata* with perfect evagination, (as have also the following): the cells urceolate or depressed, ovate, with a contracted aperture, placed at or near the anterior end, narrower than the diameter of the cell, and generally closed by a moveable lip or muscle; 3*rd*, *Ctenostomata*, with tubular or depressedly ovate cells, the aperture furnished with a setose fringe for its closure. The propriety of this division as distinct (in part) from the next and the preceding appears to me doubtful, at least as regards the species with ovate cells; there are a great many *Celleporæ* with a fringe of spines round the aperture, these being either horny and flexible, or calcareous. The 4*th* division constitute the *Cyclostomata*, with perfectly tubular cells terminating with a simple aperture of the same or very nearly the same diameter as the cell itself.

In a palæontological point of view, the *Cheilostomata* and the *Cyclostomata* only are of importance; they are both marine, and their cells are mostly calcareous, or semi-calcareous, rarely horny, and very rarely with a fleshy ectocyst. The *Cyclostomata* are decidedly the more lowly organised ones, and occur from the palæozoics upwards up to the present time, while the *Cheilostomata* are scarcely known before the jurassic period. But almost throughout the mesozoic epoch the former order considerably exceeds the latter, both as regards genera as well as species. In the kainozoic epoch the two orders almost balance themselves in number of genera, but the *Cheilostomata* appear to have a larger number of species. In the present epoch the preponderance of the last over the former is still more marked.

As regards distribution in space, it is a noticeable fact that the colder and temperate regions are richer in Ciliopods than the tropic ones, but it is not correct to suppose that they are wanting within the tropics, though they are unquestionably rare, at least within the laminarian zone near the equator. What deep dredgings in the tropics would reveal, it is difficult to predict. In the northern and temperate seas many species were found up to the greatest depth, to which dredgings have been carried on, and animal life discovered. How far we are allowed to apply general results of our observations regarding the distribution of the Ciliopods in the present seas to their distribution in former geological periods must be determined by continued and prolonged observations. But according to our present knowledge, it seems certain that both cretaceous and tertiary deposits, which are geographically situated nearer to the poles, are richer in Ciliopods than deposits of the same age situated nearer to the equator.

I. Order. CHEILOSTOMATA.

I shall use the usual nomenclature, chiefly as introduced by **Busk** into the study of this order. The only new term introduced is that of 'slitter', with which, for brevity sake, I designate those cells which begin a new row or range, and which often widely differ in size and shape from the ordinary cells. They have been called 'Spaltzellen' by **Hagenow**, because they, so to say, split two parallel rows of cells by introducing a third one between them. Why these cells should so widely differ from ordinary cells in some species of *Cellepora*, for instance, and not in others, must be settled by the examination of living-specimens.

Family,—CELLEPORIDÆ.

Colonies attached to foreign bodies, incrusting them either in single or numerous layers, or growing into variously shaped, foliaceous or branched, continuous masses of single or double, superposed or opposite, layers of cells; these are flat, depressed, or more or less convex and urceolate, generally arranged in alternating series, partially or entirely calcareous.

The extent to which, I think, this family should be accepted, will probably be best indicated when I quote a few names of the most characteristic genera, such as *Cellepora (=Lepralia* auctorum), *Eschara*, *Celleporaria*, *Membranipora* and *Biflustra.*

I will not repeat the difficulties which as yet appear to have frustrated every attempt towards a natural grouping of these genera; time and continuous research must gradually clear the path over this stony ground, but if we consult our present observations on the subject, it seems to me clear that there are chiefly two general characters to which we can assign any importance in the classification of these genera.

The one refers to the form of the individual cell, and the other to that of the colony, that is, the manner in which the cells are arranged during growth by gemmation.

As regards the first point, observations show us that there is, as a rule, a tolerably defined distinction between an urceolate and flustrine cell, the former being typified by an ovate shape, with the front, or upper, surface of the cell moderately convex, with a comparatively small aperture situated near or at the anterior end, and mostly surrounded by a slightly thickened lip. The flustrine cell, on the other hand, is flat above, often surrounded by a raised margin, and with an anterior sub-terminal or central aperture, generally of large size. However, there are cases to be met with in which it is not easy to maintain this distinction,—namely, when the upper surface of the flustrine cells becomes wholly calcareous and thickened and slightly arched, narrowing the aperture, and when the surrounding ridges are only partially developed, or almost obsolete. As an example of this kind I may cite, for instance, **d'Orbigny's** *Cellepora Xiphia* from the cretaceous deposits of France. Still even accounting for a large amount of variation, and a great number of intermediate or transitional forms, we find that the form of a normally developed and well preserved cell is constant within the limits of one species, and to a very large extent also within that of a genus as generally defined.

This same assertion could, I fear, be scarcely relied upon, if made with regard to the second point, which I have mentioned, namely, the manner in which the cells are arranged during the progressive growth of the colony. Among fossils, where, as a rule, we have to deal with mere fragments, it is extremely difficult to make any observations on the real extent and development of a colony. But among recent *Celleporæ*, for example, I am acquainted with several instances in which one layer of cells grows over the second, and is covered by a third. In the case of *Celleporaria* this growth is considered the normal one, but while there are some species which, as a rule, incrust foreign substances in superposed irregular layers, they occasionally form regular globular masses, living apparently free between sea weeds, although they might have been at an earlier stage attached to a small portion of the plant; or they grow out into cylindrical or compressed branches. Again, the recent *Eschara cervicornis* is sometimes found incrusting large masses of a foreign surface in a single layer, exactly like a *Cellepora*, until in some places two layers meet and form erect, variously branched, stems, which then possess every sign of regularity of an Escharoid colony. Now, as these variations in growth occur within the limits of a colony which we cannot by any possibility refer but to one and the same species, I believe that the manner of growth is in a classificatory point not an equally useful and reliable character,[*] as is the form of the individual cell.

With reference to the foregoing observations, and considering at the same time the close relationship of the urceolate to the flustrine form of the cell, I would propose a sub-division of the family into two sub-families, *CELLEPORINÆ* and *MEMBRANIPORINÆ*, though I readily admit that the division is framed more with a view to a practical than to a natural arrangement. I shall add brief characters of those genera which are represented in the South Indian cretaceous deposits, with some remarks regarding a few closely allied genera. The classification here adopted differs essentially from the one proposed by Smitt in Ofversigt of K. Vetensk. Akad. Förhandlinger of 1867.

A. CELLEPORINÆ.

Cells urceolate, arranged in single or numerous alternating series, colony incrusting or erect.

There are four genera represented in the South Indian cretaceous rocks.

1. *Cellepora*, Fab., 1780.

Cells incrusting foreign substances in single layers, and arranged in quincunx.

I have already[†] many years since drawn attention to the propriety of reserving Fabricius' name in its original signification, and to the altogether unfounded belief that there exists any advantage, much less any necessity, for replacing it by Johnston's name *Lepralia*, as had been suggested by Busk. Indeed, an insight into the literature of the Ciliopoda will show, that until within the last few years the name *Cellepora* has been used in all principal works of reference on this subject, and there is really not the least advantage to be gained by abandoning it at the present time.

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[*] Busk divides according to it the present family into four or five—*Membraniporidæ*, *Celleporidæ*, *Escharidæ*, *Vinculariidæ*, *Hippothoidæ*, etc., and d'Orbigny, upon still minor considerations, into about a dozen.

[†] Reise der Novara, Geol. Theil, 1st Band, 1865, p. 120.

D'Orbigny's genera *Reptescharella, Reptoporella, Repteschatripora, Reptoporina*, etc., are of course to be referred to *Cellepora;* for it is undoubtedly absurd to attempt a classification of these forms by the presence or absence of any special or accessory pores, or avicularia, between the ordinary cells, or at various places on their surface. The idea loses all foundation by the examination of almost any single, tolerably large colony, whether recent or fossil. Cells will be found with and without ovicells, and with none, or one, or two, or three avicularian pores, some round the aperture, others distributed on the surface, which, again, may be smooth, or punctate, or porose. It is absolutely impossible to assign in many cases to these organs even a specific, much less a generic, distinction, while d'Orbigny went even so far as to base separate families upon them. I am now even in doubt whether there is sufficient ground for retaining the so-called free growing forms, composed of a single layer of cells, like *Semieschatripora*, d'Orb., = *Hemeschara*, Busk, as distinct from *Cellepora*. I have no sufficient materials to entirely disprove the propriety of this and similar generic separations, but I know species of recent *Celleporæ* which, while generally incrusting foreign substances, sometimes form hemispheric or foliaceous free lamellæ, as a part of one and the same colony, and when fragments of such free portions of that colony are met with fossil, they must, properly speaking, be referred to *Semieschatripora*, while the incrusting portion of the same colony is an unquestionable *Cellepora*. Again, there are certain species which not only incrust rocks or shells and the like, but occasionally attach themselves to plants and form variously shaped incrusting masses upon these. In a fossil state the vegetable substance is lost, and the incrusting colony becomes then a free grown one. Instances of this kind may be seen in abundance on almost every shore where sea-weeds occur. For these reasons I am inclined to abandon the presumed distinction between *Cellepora* and *Semieschatripora*.

The genera *Stegenipora* and *Distegenipora* must form a distinct family, and the same applies to *Lunulites, Cupullaria*, etc., all of which had been distributed among the CELLEPORIDÆ by d'Orbigny. On the other hand, I believe that the uniserial forms, like *Hippothoa, Alsydota* and their allies, must be classed in the CELLEPORINÆ. It does not occasionally appear to be easy to define among those last named genera the urceolate form of the cell from the tubular one, and I think several of d'Orbigny's cretaceous species of *Alecto* must be classed with *Alsydota* and allied genera.

2. *Eschara*, Ray, 1724.

Cells urceolate, arranged in quincunx, colonies erect, permanently attached with the base to foreign bodies, foliaceous or variously branched, and composed of two layers with the orifices of the cells on the broad and external sides of the branches.

The name *Eschara* must be restricted to those forms which possess elongate urceolate cells, with or without any accessory pores, and with the surface finely or more largely porose; therefore, d'Orbigny's genera *Escharella*, *Escharellina*, *Escharipora*, *Porellina*, and others like *Pliophlæa*, Gabb and H., &c., are to be considered as synonyms. But there are several other species which appear to deserve to be classed in special genera or sub-genera, as is the case with the two or three following. I almost think it would be better to regard them merely as sub-genera of *Eschara*, but observations on living species are necessary to aid in the decision of this question.

2*a*. *Buskea*,* Heller, 1867, (Verh. Zool. Bot. Gesellsch., xvii, p. 89,) has the colonies with cylindrical branched stems composed of elongate urceolate cells; it corresponds to *Vincularia* of the next sub-family.

3. *Escharifora*, d'Orb., 1851.

Colonies branched, in two opposite layers. Cells quadrangular, with the apertures transverse in a slight depression, below which the surface is more or less tumescent, arranged in V - form series.

When the cell surface is much worn off, this genus is almost inseparable from *Flustrella*, which represents it in the next sub-family.

4. *Porina*, d'Orb., 1851.

Colonies branched; cells arranged in two opposite layers, or all round the stem, urceolate, often not distinctly separated from each other, and provided with a more or less tubular aperture.

As one of the most typical species of this genus, I quote d'Orbigny's *Porina filiformis*.

5. *Polyeschara*, Reuss, 1867. Sitzungsb. Akad. M. N. Klasse, Wien, Vol. lv, pt. i, p. 226.

Cells urceolate, arranged in double or more superposed layers on branching stems, separated by a lamina in the centre. Type, *P. confusa*, Reuss, from lower oligocæn beds.

In addition to these genera, it may be useful to retain *Lanceopora* and a few others.

6. *Celleporaria*, Lamx., 1821.

Colonies incrusting, often partially free, forming round, lamellar or branched masses, composed of numerous, more or less regularly, superimposed layers of urceolate cells.

Although I readily admit that some species of *Celleporariæ* retain to a certain extent a constant form in growth, I have great doubts, –since I had opportunity of examining and observing a great number of living species,– that it will be possible to assign a generic value to such forms as have been separated by d'Orbigny under the names of *Semicelleporaria*, *Reptocelleporaria*, *Multiporina*, *Multescharellina*, *Multescharinella*, *Multescharipora*, etc., to which may be added *Ennalliopora*, Gabb and Horn, which authors also established a *Multiporina*, but apparently in the same sense as proposed by d'Orbigny.

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* Not *Buskia*, Reuss, 1864, Sitz. M. N. Klasse, Akad., Wien, vol. L, p. 677.

Somewhere in the proximity of *Celleporaria* must apparently be classed *Flabellopora*, d'Orbigny, *Cumulipora*, v. May. (Comp. Reuss in Sitzb. Akad., Wien, M. N. Klasse, vol. 50, p. 642), *Orbitulipora*,[*] Stol. (Sitz. Akad. M. N. Klasse, Wien, vol. 45, pt. i, p. 90,) and possibly also *Bicupularia*, Reuss, (ibid. vol. 50, p. 205,) with the type species *B. lenticularis*. The classification of these free growing Ciliopoda in the *CELLEPORIDÆ* is, however, doubtful. I shall allude to them again in the *SELENARIDÆ*.

B. MEMBRANIPORINÆ.

Cells flustrine, being depressed, usually surrounded by a raised margin, with the upper calcareous portion slightly convex or flat, and with the aperture either sub-terminal or sub-central, and of moderate or large size; sometimes the entire upper surface is horny, with the aperture not well defined. Colonies entirely attached to foreign substances, or only with the base of the ramose stems.

Between the true Membraniporid cell, which is almost entirely open in front, and the urceolate cell, there exist many intermediate forms. One of the best marked is that of a depressed shape, having the upper surface calcareous, almost quite flat, pierced by a comparatively small, well defined, aperture, situated near the anterior end, and the whole is surrounded by a raised margin. This form of the cell may be called *Discoporid*, and the typical species possessing it might be grouped into a distinct sub-family, intermediate between the *CELLEPORINÆ* and *MEMBRANIPORINÆ*; but as the majority of the species are intimately connected with those of the latter sub-family, I prefer for the present not to carry the division of the family further. The gradual transition from a horny surface to a partially and at last entirely solidified and calcareous one may best be studied in recent species, as may be seen from a comparison of the description and figures of my *Membranipora Bengalensis* in Journal Asiat. Soc., Bengal, 1869, vol. xxxviii, pt. ii, p. 55, pl. xii.

7. *Discopora*, Lam., 1816.

Cells flat, with the aperture near the anterior end, surrounded by slightly thickened lips, each cell with a raised margin; colonies incrusting foreign substances in single layers.

Although Lamarck's name has in the sense, as here used, been employed by a few palæontologists only, I do not think that there can be any serious objection to it, and I believe that it is far preferable to many of the cruel combinations introduced by d'Orbigny. What I have stated regarding the variations of growth of *Cellepora*, chiefly depending upon the form and character of the foreign substances on which it grows, equally applies to *Discopora* and to *Membranipora*. With the former, therefore, *Reptescharinella* must evidently be united, and the distinction of *Semieschara*, *Semiescharinella*,[*] *Semiescharellina*, (in part) and of some others, is very doubtful, for the same reason which I noticed when speaking of *Cellepora*.

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[*] Reuss identifies (Sitz. Akad., Wien, vol. 55, pt. i, p. 217,) the type species of this genus *O. Haidingeri* with *O. (Cellepora) petiolus*, Lonsdale, apud Dixon. Judging from the figure of the latter, the median cells are much more numerous, and all are more depressed and with a more transversely expanded aperture. I am by no means sure that this identification will hold good.

8. *Membranipora*, Blainville, 1834.

Cells widely open in front, the facial surface remaining solid only to a small extent near the base, except in very old cells, which gradually become entirely closed; colonies incrusting foreign substances in single layers.

The *Membraniporæ* are numerous in nearly all the formations, in which *Cheilostomata* occur, and also in the present seas, but the determination of the fossils is occasionally accompanied with a great amount of uncertainty; for in many instances the aspect of the cells entirely depends upon the state of preservation, and in others the injured cells of *Celleporæ* are hardly to be distinguished from some *Membraniporæ*.

Besides this the amount to which the originally horny or chitinous cell becomes calcareous seems to vary both according to age as well as individually and locally, as I have illustrated at length in *Membranipora Bengalensis*,[†] above referred to.

D'Orbigny's *Flustrellaria*, *Semiflustrella*, *Lateroflustrella*, *Reptoflustrella*, and similar combinations of *Flustrina* are very doubtfully separable from *Membranipora*.

9. *Flustrella*, d'Orb., 1852.

Cells solid, more or less confluent with each other, provided with an elongated, sub-central, almost slit-like aperture, and usually one or two elevated tumid pores below it. Colonies ramose, compressed, with the cells arranged in longitudinal alternating series on two sides of the compressed branches. The cretaceous *F. polymorpha*, d'Orb., may be considered as one of the characteristic species of this genus. Several of the species described by d'Orbigny under *Flustrina* appear also to belong to this genus, but others are to be referred to one or the other of the two following genera.

10. *Escharinella*, d'Orb., 1852.

Cells depressed, surrounded by raised margin, with the facial surface solid and pierced in the anterior portion with a transversely elongated or semi-ovate aperture;

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[*] D'Orbigny's *Multescharinella*, (like so many others beginning with *Repto-*, *Semi-*, *Multi-*, *Sparsi-*, &c.,) is a purely imaginary thing, for Reuss' *Cellepora prolifera*, for which the new generic name was employed, is a peaceable *Celleporaria*.

[†] When Prof. Leukart complained of the imperfect description which I gave of this species, he does not appear to have been aware that he had merely the abstract of the paper before him, (Comp. Troschel's Archiv, vol. 35, pt. ii, p. 341), but when he suggests the probable identity with *Hislopia*, it only shows how little my friend was at that time acquainted with the latter genus.

colonies generally broadly foliaceous and branched, the cells arranged in two opposite layers on the compressed branches, separated by a lamina.

A typical species of this genus is *E. Argia*, d'Orb., and the greater number of those described by the same author under *Eschara* also belong to it.

11. *Vincularia*, Defr., 1829.

Cells quite similar to those of *Escharinella*, but arranged in a single layer all round the surface of cylindrical, branched stems, without an intervening lamina.

This genus is very extensively represented both in fossil and in recent state; it only differs from *Salicornaria* by the branches of the colonies being continuous and permanently attached to each other without any articulation.

Next to *Vincularia* comes Hagenow's *Inversaria*,* merely differing from the former by the hollow axis of the stems. Whether this excavated axis is really natural and peculiar to that genus, or whether it is simply the result of some soft organic substance having been lost by decay, has, I think, yet to be proved by further observations.

12. *Biflustra*, d'Orb., 1852.

Cells depressed, surrounded by a raised margin and widely open in front, as in *Membranipora*; colonies foliaceous and branched, with the cells arranged in two opposite layers, separated by a lamina. *B. regularis*, d'Orb., from the Chalk may be regarded as the typical species of this genus, which is largely represented in a fossil state, but is more rarely found recent.

Of the uniserial species, *Filiflustra*, *Pyripora*, and *Filiflustrellaria* of d'Orbigny ought, I believe, to be referred to the MEMBRANIPORINÆ. On the other hand, the free growing species represented by *Cupularia*, *Trochopora*, &c., have to form a separate family. The same applies, I believe, to *Myriozoum* and *Melicerites*, which no doubt belong to the close proximity of *Nodelea*, *Escharites* of Römer, and their allies, &c., and which have by d'Orbigny been separated into two distinct families, though one common name would probably suffice for both.

I should also mention *Retepora*, which is often classed next to *Eschara*. But the structure of the colony of *Retepora* appears to be a very peculiar one; the substance contains a considerable proportion of silica, and I am inclined to uphold the old family RETEPORIDÆ as distinct from the CELLEPORIDÆ. Next to *Retepora* will no doubt have to be classified *Filiflustrella*, and probably also *Filiflustrina* of d'Orbigny, while Gabb and Horn's *Phidolopora* (Journ. Acad. Nat. Sc., Phil., 2nd ser., vol. v, p. 138,) does not in the least differ from *Retepora*, as generally understood. In the species *Ph. labiata*, described by the American authors, some of the cells merely have below the aperture a special or avicularian pore, margined below by a raised horse-shoe-shaped margin, gradually sloping towards the base of the cell, but a similar structure is to be found in nearly all the *Reteporæ* which I have had occasion to examine, both recent and fossil.

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* Bryozoen Maast. Kreide, 1851, p. 57.

I. CELLEPORA, *Fabr.*, 1780, (see p. 6.)

1. Cellepora prona, *Stoliczka,* Pl. I, Fig. 1.

Cell. colonia cellulis urceolatis, parvis, decumbentibus, parte anteriori elevatis et contractis composita, cellulis in superficie tota porosis, sulcis angustis, haud precipue distinctis, et in coloniis antiquis sub-obsoletis separatis. Apertura parva, subrotundata, fere horizontali, marginibus valde incrassatis circumdata, poris avicularioram tribus subverrucosis instructis, uno in utroque latere tertioque medio labii sito. Ovicellulis rare conspicuis, parvulis, rotundatis, paulo elevatis, ad basin cum labro aperturæ fere confluentibus, superficie lævigatis.

The cells of this species are very small, with the anterior part contracted, elevated and thickened, while the posterior is almost horizontally reposed, in younger colonies somewhat convex and separated from each other by slight impressions, which in old colonies become nearly obsolete. The entire surface is rather coarsely porous or almost scrobiculate. The aperture is nearly in a plane, small, sub-rotundate, with very thickened lips and three verrucose avicularian pores, one on either side, and the third situated about the middle of the underlip. The ovicells appear to be rarely developed; they are rounded, small, smooth, and at the base nearly confluent with the upper lip. When the surface of the ovicells has been broken in, the thickened upper lip becomes better marked and shows a large pore above it in the place of the ovicell.

Locality.—North of Poodoopolliam, incrusting *Terebratula subdepressa,* Stol., occurring in a pinkish-yellow sandy limestone.

Formation.—Arrialoor group.

2. Cellepora puncticulata, *Stoliczka,* Pl. I, Fig. 2.

Cell. colonia cellulis sub-cylindraceis, decumbentibus, lævigatis, punctis inæqualibus plus minusve distinctis separatis; apertura terminali, antica, transverse subrotundata, margine obtuso paulum incrassato circumdata, declivi, labro fere immerso, labio convexiusculo et elevato; ovicellulis supra aperturam positis, eamque in magnitudine fere æquantibus, paulo convexis, solidulis, nonnunquam fissurá parvá supra labrum aperturæ sita instructis. Fissoribus formá cellulis ceteris similibus, sæpissime aliquanto minoribus.

A very characteristic species, the cells being, like in the previous one, decumbent, but separated from each other by irregularly punctated, or rather scrobiculate, impressions. The form of the cells is subcylindrical, moderately convex, with the aperture anterior, terminal, transversely subrotundate, slanting, the upper lip being nearly immersed, while the lower lip is considerably elevated, and in most specimens the cell below it is slightly constricted. The ovicells are placed above the aperture, and very nearly equal this in size; they are slightly convex, and occasionally with a small slit situated above the upper lip of the aperture; they are entirely separated from the next following cells, not resting on their bases, as is very often the case in similar forms.

Locality.—Chokonadapooram, sessile on the shells of *Exogyra ostracina*, Lam.

Formation.—Arrialoor group.

3. CELLEPORA INSIPIENS, *Stoliczka*, Pl. I, Fig. 3.

Cell. colonia cellulis sub-ovatis, seu late sex-angulatis, decumbentibus, in superficie, minutissime porosis, aperturam versus modice elevatis et convexiusculis, carina elevata plus minusve distincter separatis, composita; apertura antica, sub-terminali, fere horizontali, sub-triangulariter semi-elliptica, margine incrassato circumdata, labio paulum elevato, fere recto, utrinque ad terminationem minute inciso. Fissoribus inter cellulas regulares sparsis, iis multo minoribus, depressis, sub-quadrangularibus, postice breviter angulatis, antice valde productis atque flagellatis, orificio lineari et longo ad basin paulo dilatato instructis.

The cells are depressed, sub-ovate, or sub-hexagonal, provided with more or less distinct, sub-marginal superficial ridges, which, however, occasionally become quite obsolete. The surface is very finely punctated, or often apparently quite smooth, slightly elevated, particularly towards the aperture, which is semielliptical, nearly quite anterior, and almost horizontally placed; it is surrounded by a thickened margin, the lower lip being straight and having a minute incision at each end. The slitters are interspersed between the other cells; they are much smaller than these, depressed, somewhat diamond shaped, anteriorly much attenuated and produced into a point, with an elongated slit-like aperture. No avicularia or ovicells have been observed

This species is closely allied to d'Orbigny's *C. xiphia* (Pal. Franç. Terr. Cret., v, p. 413, pl. 717, figs. 3 and 4), the latter differing from the Indian form by a more elongated shape of the cells, and by the occasional development of what appear to be true avicularian pores.

Locality.—North of Poodoopolliam, on *Terebratula sub-depressa*, Stol., forming widely spread colonies.

Formation.—Arrialoor group.

4. CELLEPORA MISSILIS, *Stoliczka*, Pl. I, Figs. 4–5.

Cell. colonia cellulis ovulatis, ad basim angustatis, paulum convexiusculis, fere planis, in superficie rugulose minuteque porosis, sulcis plus minusve distinctis, angustis ac lævigatis separatis; apertura antica, horizontali, falciformi, margine paululum incrassato circumdata, labio medio aliquanto producto elevatoque; ovicellulis (nonnunquam obsoletis seu detritis) semiglobosis, lævigatis, basim cellularum sequentium partim obtegentibus, supra labrum ostio magno transversim ovali apertis. Fissoribus *parvis elongatis, apertura minima rotundata instructis, earumque ovicellulis breviter flagellatis, ad basim ostiolum spaciosum elongate triangularem gerentibus.*

This form is readily distinguished from all other known cretaceous species by the shape of the aperture, which is regularly sickle-shaped, surrounded by slightly thickened margins, and by the peculiar form of the slitters, these being small, elongated, and provided with a minute rounded aperture, while their ovicells are almost flagellate and with a much larger, sub-triangular opening. The cells are, when well preserved, slightly convex, ovate, being narrower at the base, somewhat irregularly punctated and separated from each other by narrow smooth sulci, which in very old cells become less distinct, or almost obsolete. The ovicells partly cover the base of the succeeding cells; they are semiglobose, smooth, provided with a rather large, transversely elliptical opening, situated just above the upper lip. The margins of that opening appear to have been very thin, and are easily broken off, in consequence of which the size of the opening is very variable.

Sometimes the ovicells do not appear to become developed, and in this stage the species closely resembles *Cell. hippocrepis* of Goldfuss from Maastricht, but the cells want the semiovate raised rim, which in the latter species surrounds the upper portion of each cell. (*See* fig. 5 on pl. i).

When old colonies become much worn off, the upper surface of the cells is nearly flat, or even a little concave towards the aperture, and the boundaries between the cells are almost raised instead of depressed. In this stage the species closely resembles *Escharinella discors*, n. sp. (*vide* p. 18).

Localities.—North of Poodoopolliam and at Chokonadapooram, incrusting *Oysters* and *Terebratulæ*.

Formation.—Arrialoor group.

II. ESCHARA, *Ray*, 1724, (see p. 7).

1. ESCHARA OPTABILIS, *Stoliczka*, Pl. I, Figs. 6–7.

Esch. ramulis aut rotundatis aut modice explanatis foliaceisque; cellulis elongate sub-hexagonis, lævigatis, convexiusculis, sulcis angustis simplicibus separatis; apertura fere antica, rotundate sub-quadrangulari, margine vix incrassato circumdata. Fissoribus parvis, sub-ovatis, basi flexuose attenuatis, apertura sub-centrali, elongatim acute eliptica instructis.

Fragments of stems are either cylindrical, in which case they might be referred to Hellers' *Buskea*, or they are more or less expanded and foliaceous. The cells are very simple, elongately sub-hexagonal, slightly convex, entirely smooth, and without any accessory pores. The aperture is roundly sub-quadrangular. The slitters are of moderate size, narrowly and somewhat flexuously elongated at the base, and provided with an acutely elliptical sub-central aperture.

Locality.—Ootacoil, in a pink limestone.

Formation.—Arrialoor group.

2. Eschara porigera, *Stoliczka*, Pl. I, Fig. 8.

Esch. ramulis latis, compressiusculis, cellulis elongatis, depresso cylindraceis et modice elevatis compositis, superficie supera glabris, planiusculis, prope margines laterales infraque serie continua pororum undecim, transverse elongatorum, instructis; apertura antica, spaciosa, semi-elliptica, labio recto glabroque declivi; avicularis duobus, uno in utroque latere labri sito, tumido, orificio parvo atque rotundato instructo.

A single fragment of a compressed branch indicates that the stem of this species must have been rather broadly foliaceous. The cells are elongate, moderately elevated, with the upper surface flattened and the sides all round slanting; the former is along the lateral and lower margins provided with a continuous series of eleven transversely elongated pores. These pores begin a short distance from the straight lower lip of the aperture, which latter is entirely anterior and of a semi-elliptical shape. On each side of the upper lip lies a tumid, rounded avicularium, possessing a small rounded opening.

The species is evidently closely allied to *Eschara incrassata*, (d'Orbigny), (Pal. franç. terr. cret., v, pl. 685, figs. 1-4), which differs in having the pores more numerous and extending up to the edge of the lower lip, and also by having the avicularia placed above, instead of at the side of the aperture.

Locality.—Chokonadapooram, in a pinkish sandy limestone.

Formation.—Arrialoor group.

III. ESCHARIFORA, *d'Orb.*, 1851, (see p. 8).

1. Escharifora ortiva, *Stoliczka*, Pl. I, Fig. 9.

Esch. ramulis angustis, dichotomis, modice compressiusculis; cellulis sub-quadrangularibus, sulcis simplicibus haud distincter separatis, in seriebus a medio divergentibus dispositis, aperturis sub-medianis, tumescente sub-tubulosis atque rotundatis instructis, quaque circa marginem aperturæ poris parvis circiter six, (quorum eo sub labio posito maximo), atque in facie inferiore uno vel duobus alteris notata.

This is most closely allied to *E. vicinalis*, described by Von Hagenow from the Maastricht beds (Bryoz. der Maastricht. Kreidebildung, &c., 1851, p. 63, pl. vii, fig. 6). The peculiarity of this species consists, however, in the presence of a slit-like opening at the base of each cell, or rather the pore is placed in the centre between each four cells, and is narrowly prolonged on to the surface of the succeeding cell above it. In place of this slit-like opening, there are in the present species two small pores on the surface of each cell, placed one below the other, but none at the base of the cell itself. Besides there are generally six pores round the aperture, the one, placed a short distance below the lower lip, being usually conspicuously larger than any of the others, and often somewhat transversely elongated. The cell surface is towards the aperture distinctly elevated, and on the margins of the stem it assumes a more or less distinctly tubular shape.

Locality.—Yermanoor, in yellowish sandy beds.

Formation.—Arrialoor group.

2. Escharifora omninosa, *Stoliczka*, Pl. I, Fig. 10.

Esch. colonia late foliacea atque varie contorta, cellulis confluentibus, in superficie haud distincter separatis, lævigatis, quaque in parte antica apertura sub-semilunari, paulo immersa, infra aperturam tumore obtuso, antice directo, ad terminationem plus minusve aperte perforato, et prope basim poris duobus minutis prædita.

The cells are in this species confluent on the surface, only slight depressions being indicated between some of them. The aperture is roundly semilunar, and is somewhat impressed with sloping, not specially defined margins. Below the aperture each cell is elevated, the swelling being somewhat conical, with the point directed anteriorly and more or less widely perforated. Besides this there is a pair of moderately distant minute pores near the sloping base of each cell. The surface is in other respects smooth, merely possessing the usual microscopic punctuation.

Locality.—North of Poodoopolliam, in limestone.

Formation.—Arrialoor group.

IV. *Genus.*—CELLEPORARIA, *Lamouroux*, 1821.

This genus merely differs, as already stated, from *Cellepora* by the manner of growth, the cell layers being numerous and generally irregularly superimposed. The colonies are either incrusting other objects, or they form short, blunt, rounded and more or less ramified stems.

The species of the genus are tolerably numerous in the present seas, and they were also abundant in the tertiary epoch, but very few are known from cretaceous rocks.

For this reason only I mention the occurrence of a short, dichotome, blunt stem of a species of this genus in the sandy Arrialoor beds at Chokonadapooram, but the cells are so much worn down and injured that it would be worthless to look for any distinctive characters in them. They appear to be slightly convex, smooth, elongately ovate, indistinctly separated from each other by narrow depressions, with a small anterior semilunar aperture and a few minute pores interspersed between the cells. Until better specimens have been procured the species must remain undetermined. Figures 11 and 11 *a* on plate I give an illustration of the stem of the natural size.

V. DISCOPORA, *Lamarck*, 1816, (see p. 9).

1. Discopora obtecta, *Stoliczka*, Pl. I, Fig. 12.

Dis. coloniis extensis, cellulis depressis planisque compositis, hexagonis, plus minusve elongatis, lævigatis atque carina elevata communi, medio obsolete sulcata, circumdatis; apertura mediocri, antica, sub-terminali, transverse semiovata, marginibus paululum incrassatis. Fissoribus elongate ellipticis, utrinque acute terminantibus, concavis, orificio ovato sub-mediano instructis.

The cells in this species are almost regularly hexagonal, with the upper surface entirely flat, but calcareous, and as the aperture is comparatively small and surrounded by slightly thickened lips, I think it should be referred to the above genus. The ridges which separate the cells are very indistinctly furrowed along the crest, indicating the boundaries of each two adjoining cells. The slitters are large, elongately ovate, with acute terminations, concave above, and with a sub-median oval aperture. No ovicells or avicularia have been observed.

Localities.—Yermanoor and Chokonadapooram, forming rather extensive incrusting layers on Oysters.

Formation.—Arrialoor group.

VI. MEMBRANIPORA, *Blainville*, 1834, (see p. 10).

1. Membranipora pedata, *Stoliczka*, Pl. II, Figs. 2–3.

Memb. cellulis depressis, planis, lævigatis, plus minusve elongate hexagonis, lineis impressis separatis, basi valde contractis, tectis, medio latissimis, parte anteriore modice angustatis, nonnunquam semiovatis; apertura fere dimidium longitudinis cellularum occupante, sub-ovata vel sub-pyriformi, antice paulo angustata, marginibus declivibis, radiatim breviter striatis. Cellulis antiquis fere regulariter hexagonis, sæpissime fere omnino convexiuscule tectis, quaque ostio minimo sub-mediano perforata.

Cells depressed and flat, separated by very fine impressed lines, elongately hexagonal, widest in the middle, much more contracted posteriorly than anteriorly. The length of the cells is subject to considerable variation, apparently depending upon the more or less plain surface which they incrust. The aperture is placed in the anterior half, and is ovate or somewhat pear-shaped, its upper part being slightly contracted; its margins are finely radiately striated. In a colony the median or oldest cells are generally almost regularly hexagonal, or at least much shorter than the younger cells, and apparently with age they become entirely covered with a very slightly convex calcareous smooth membrane, perforated about the middle by a very small rounded opening, and many cells have besides this another small opening in different places of the membrane, but generally sub-marginal.

Locality.—Ninnyoor, forming thin incrusting layers on Oysters.

Formation.—Arrialoor group.

2. MEMBRANIPORA AURICULATA, *Stoliczka*, Pl. II, Fig. 4.

Memb. cellulis in seriebus regularibus alternantibus positis, elongatis, postice angustatis et solidulis, antice latioribus atque apertura magna, indistincte marginata, regulariterque ovata instructis; avicularis duobus supra aperturam sitis, parvis atque plus minusve tumescentibus.

A species with comparatively very small cells, arranged in very regular alternating series. The cells are elongated, much narrower at the base, and with a solid smooth covering; the anterior half, or more, of the front surface is widened, and nearly all occupied by very regularly oval wide apertures. The furrows between the cells are sometimes scarcely traceable. Each cell has above the aperture two small, slightly tumid avicularia, and as the cells of the colony are arranged in quincunx, it gives the appearance of each of them being surrounded by six raised pores.

Locality.—North of Poodoopolliam, forming very thin coverings on *Terebratula sub-depressa*, Stol.

Formation.—Arrialoor group.

VII. ESCHARINELLA, *d'Orbigny*, 1851, (see p. 10).

1. ESCHARINELLA DISCORS, *Stoliczka*, Pl. II, Fig. 1.

E. colonia late foliacea; cellulis planis, fere regulariter hexagonis, interdumque modice elongatis, carina subobtusa circumdatis, lævigatis; apertura in parte antica paulo depressa sita, sub-quadrate semilunari, labro intus lamina parva descendente instructo, labio fere recto seu paulisper flexuoso. Ovicellulis subrotundatis, clausis, aut supra labrum late apertis, ostii margine superiore elevato, hipposideriformi, margine inferiore medio breviter linguiforme producto; nonnunquam ovicellulis in facie omnino apertis, vel etiam obsoletis. Fissoribus elongate ovatis, utrinque ad terminationem sub-obtuse angulatis, medio depressis, quaque ostio ovali instructo.

This is an extremely variable species and closely allied to several European species described from the Chalk of France and from Maastricht, but the comparatively large size and form of the apertures and of the slitters readily distinguish it. On the average the cells are almost regular, hexagonal, sometimes in longer stems moderately elongated, with smooth, flat anteriorly somewhat depressed surface, and surrounded by elevated ridges on which the finely impressed lines, separating the cells, are scarcely traceable. The aperture is moderately large, somewhat angularly semilunar, with scarcely thickened margins. The upper lip has inside a small descending lamina, and the lower lip is nearly straight, or very slightly undulating.

The ovicells are rounded, semiglobose, entirely closed, or open in front, the upper lip forming a horse-shoe-shaped thin margin, while the lower lip is slightly produced in the centre. Sometimes the elevated upper lip is broken away, and then the ovicells appear as rounded or ovate depressions, and in other cases they are entirely worn away, or do not appear to have become at all developed. All these stages may be seen in one and the same colony, as shown in fig. 1, on pl. ii.

The slitters are elongately ovate, with similarly shaped sub-central, depressed apertures.

When the surface of the colonies has been slightly worn off, the ridges between the cells disappear, while the impressed lines between them become more distinct. At the same time the aperture slightly widens by the fine edges, or laminæ, being broken away, and assumes either a roundly quadrangular or nearly rounded shape. The oral region is, however, always somewhat depressed.

Localities.—Yermanoor, in yellowish sandy beds, Chokonadapooram and Ootacoil, in a pinkish limestone; very common.

Formation.—Arrialoor group.

VIII. *Genus.*—BIFLUSTRA, *d'Orbigny*, 1851, (see p. 11).

1. Biflustra cingulata, *Stoliczka*, Pl. II, Fig. 6.

Bif. ramulis latis, compressis; cellulis magnis rotundate sub-hexagonis, in seriebus obliquis dispositis et sulcis angustis separatis; apertura magna, late ovata, subantica, margine undique elevato circumdata; fissoribus cellulis paulo minoribus, rhombiformibus atque in dimidio supero margine valde elevato præditis; apertura elongate eliptica.

A very characteristic species, with broadly foliaceous, compressed branches. The cells are large, sub-hexagonal, with ovate, somewhat anteriorly placed apertures; each cell is surrounded by an elevated margin and separated from the neighbouring ones by narrow grooves. The slitters are somewhat smaller than the other cells, diamond-shaped, with a similarly formed aperture, and on the upper half of each the margin is very much higher than on the lower one. No ovicells have been observed.

Locality.—Yermanoor, in a yellowish soft sandstone.

Formation.—Arrialoor group.

2. *Family,—SELENARIIDÆ.*

Busk, Crag Polyzoa, Palæonto. Soc., p. 78.

Colonies more or less orbicular or conoid, composed of a single layer of cells, with their orifices all on one side only; partially attached when young, but usually quite free when adult; cells broadly urceolate, with a rather large aperture, or flustrine, mostly with well developed vibracular cells.

The attachment of the colonies is usually only indicated by the central or oldest cell being fixed to a small portion of shell or a grain of sand, which does not in any way interfere with the movements of the whole colony when it is adult.

It appears to be merely an exceptional case when the colony remains permanently attached to a foreign body.

This family must be based upon the growth of the colony, or else it could not exist at all. In the present case, however, that the manner of growth can be used as a principal divisional character is due to the fact that it is independent of the form or structure of the foreign subject to which the first cell attaches itself, and that, therefore, the colony may be considered as a free-growing one. If this circumstance were not considered important enough, the genera would have to be distributed into other families, as has been done by d'Orbigny.

The genera belonging to the family are—

1. *Lunulites*, Lamx.

Cells depressed, widely open in front, vibracular cells in more or less complete radial series alternating with the regular cells. Colonies free, orbicular, obtusely conoid or cupuliform.

This is the only genus representing the family by a single species in the South Indian cretaceous deposits.

Whether *Pavolunulites* of d'Orbigny should be regarded as an abnormal form of this family, or of the CELLEPORIDÆ, I am not prepared to say, as I never had an opportunity of examining any of the species belonging to it; but I believe that d'Orbigny's *Reptolunulites* is nothing else but a *Dicopora*, and that it must be referred to the MEMBRANIPORINÆ.

Oligostresium, Gabb and Horn, (Journ. Acad. N. S., Phil., 2nd ser., v, p. 139,) only differs from *Lunulites* by having the vibracular cells not equally numerous as the ordinary cells, but scattered and fewer in number. This, however, also occurs sometimes in species of *Lunulites* (for instance, *L. Hagenowi*, Bosq.), the vibracula being regular on one side of the colony and fewer and scattered on the other. For this reason it seems to me very doubtful that *Oligostresium* will prove sufficiently distinct from *Lunulites*.

2. *Heteractis*, G. and Horn, (ibidem p. 156). Colony, form of cells, and position of vibracula exactly as in *Lunulites*, but the cells do not radiate from the centre; moreover, they are arranged in straight series, branching off from a line of larger cells, passing diametrically through the centre of the colony from one end to the other.

3. *Selenaria*, Busk, has discoporid cells with a few others interspersed, of somewhat different shape and structure, provided with vibracular openings in place of the ordinary aperture.

4. *Stichopora*, Hagenow, forms suborbicular colonies, with depressed, anteriorly widely open cells, exactly as in *Lunulites*, but without any special vibracular cells.

The species referred by d'Orbigny in his Pal. française, vol. iv, to *Lunulites* belong to *Stichopora*; and I am by no means certain that d'Orbigny's *Discoflustrellaria* differs from it, unless it be on account of the perfectly flustrine form of the cells, being entirely open in front, while in *Stichopora* they are discoporid, being only anteriorly provided with an aperture. A further doubtful genus is d'Orbigny's *Lateroflustrellaria*. The only species known is not to be distinguished from a *Stichopora*, of which the marginal cells have been lost.

5. *Stichoporina*,[*] Stoliczka. Colonies in form similar to *Lunulites;* cells urceolate, moderately inflated, polygonal, with a small, rounded subterminal aperture, increasing in size and becoming ovate towards the periphery, but without any vibracula.

6. *Conescharellina*, d'Orb. Colony conoid, solid, composed of cells radiating from a longitudinal axis; cells urceolate, provided with a rounded aperture, with or without avicularia, and sometimes with smaller interposed cells which probably represent vibracula. Type, *C. angustata*, d'Orb., recent. Other species are found both recent and in tertiary deposits. With this genus *Batopora*[†] of Reuss is evidently identical.

7. *Trochopora*, d'Orb. Colony conoid, solid, composed of long cells, arranged more or less parallel or inclined to the longitudinal axis, flattened on the surface and provided with large apertures, without any avicularian or vibracular cells. Type, *Tr. conica*, Defr., from tertiary beds.

8. *Cupularia*, Lamx. Colonies depressly cupuliform, convex or slightly flattened above, concave or flat below; composed of a single layer of radiately arranged cells, depressed above, and each provided with a small vibraculum above the aperture.

From this genus, d'Orbigny's *Discoporella* and *Discoflustrella* are, I believe, not generically distinct.

9. *Diplotaxis*, Reuss (Sitzungsb. Akad., Wien, M. N. Klasse, vol. 55, 1867, pt. 1, p. 231). Colony discoid, convex above, plain or slightly concave below, cells radiating from a centre and increasing in length the more they are distant from it; their outer surface is generally flattened, irregularly polygonal, and indistinctly spirally arranged; on the convex surface all are provided with large irregularly ovate or rounded apertures, and each has a small vibraculum on the anterior end; on the concave side only some of the cells have elongated apertures, others are closed; vibracula are few, except a row at the periphery. Type, *D. placentula*, from lower oligocæn beds.

This is an abnormal form of *SELENARIIDÆ*, and forms an intermediate link between the typical species of the family and *Orbitulipora*, *Bicupularia*, and *Flabellopora*, all which might almost with equal propriety be classed in this place, instead of in the proximity of *Celleporaria*.

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[*] Sitzungsb. Akad., Wien, M. N. Klasse, vol. 45, 1862, p. 92, and Reuss, *ibidem*, 1867, vol. 55, pt. I, p. 219.

[†] *Ibidem*, 1867, vol. 55, p. 223.

IX. LUNULITES, *Lamx.*, (see p. 20).

1. LUNULITES ANNULATA, *Stoliczka*, Pl. II, Fig. 5.

Lun. colonia cupuliformi; cellulis quadrangularibus, longitudinaliter confluentibus, marginibus undique sed precipue in parte anteriore elevatis; apertura sub-antica, spaciosa, immersa, subquadrangulari; labio fere recto; seriebus avicu-lariorum tertiam partem latitudinis cellularum æquantibus, orificiis elongate ovatis.

The colony is regularly cupuliform, with the cells equally regularly disposed in radiating as well as in concentric series, and as the anterior margin of each cell is considerably more elevated than the posterior one, the whole colony has the appearance of being composed of rings, successively increasing in diameter, like the steps of an amphitheatre. The aperture is subquadrangular, placed anteriorly, and the upper elevated margin often slightly overhangs it; its lower edge is nearly straight. The avicularia lie in depressions, which have only one-third the width of the regular cells, and are provided with elongately ovate apertures.

In colonies with an imperfectly well preserved surface the margins become more or less easily worn off, and the orifices of the cells larger and of a rounded or oval shape.

Locality.—Comarapolliam, in pale coloured, coarse sandstone.

Formation.—Arrialoor group.

3. *Family,—CELLARIIDÆ.*

(*CELLARIDÆ*, d'Orb. et auct. *SALICORNARIIDÆ*, Busk, et auct.).

The genera belonging to this family are chiefly characterized by the articulated, cylindrical or moderately compressed, branched stems, the single branches being joined to each other by fibrous, most probably chitinous or horny strings, usually terminating pointedly at the base and truncate at the anterior upper end. The cells are disposed all round the stem, or on two opposite sides, and are either of the urceolate or flustrine shape, with or without ovicells, or vibracula.

According to this marked difference in the form of the cells the family may be divided into two sections, the former being represented by the true *Cellariæ* (type *C. opuntioides* or *C. cereoides),* and the latter by *Salicornaria* of Cuvier, (type *S. farciminoides*, Johnst.). I have elsewhere[*] discussed in great detail the relation of these two genera, which by most authors had been wrongly considered as identical with each other; but while separating these two typical forms, I have attempted to prove that *Glauconome* of Münster is the same as *Salicornaria*, and that, on the other hand, *Margaretta*, Gray, *Tubucellaria*, d'Orb., and *Onchopora*, Busk, cannot be maintained as distinct genera from *Cellaria*. The species which were originally described and figured by d'Orbigny under the name of *Cellaria* in Vol. V, Pal. franç. terr. cret., are unquestionably to be referred to *Salicornaria*, and those described as *Quadricellaria* are probably also not distinct from the latter

[*] Fossile Bryozoen von Neu-Seeland, Reise der Oest. Fregatte Novara; Geol. Theil., 1st Band, 1865, p. 142, et seq.

genus, though I do not wish to be positive on the last point, as I had no opportunity of examining any of the typical specimens figured by d'Orbigny. Of the other genera recorded in the family, d'Orbigny's *Planicellaria* and *Fusicellaria* appear to be fairly separable from *Salicornaria*, although very closely allied to it. *Nellia*, Busk, and *Poricellaria*, d'Orb., I do not know at all. What Sars called *Quadricellaria* stands in somewhat similar relation to *Cellaria*, as does d'Orbigny's genus of the same name to *Salicornaria*, the form of the colonies and position of the cells being in both similar, but the branches are not articulated, and therefore Sars' genus must be denoted by another name. (Comp. Quart. Jour. Micros. Sc., 1864, p. 101). *Palmicellaria* of Alder (Quart. J. Micros. Sc., IV, 1864, p. 100,) might also from its name be thought to belong to this family, but as the colony is inarticulate, and as the branches do not show 'even a sign of contraction at their bases,' the genus must be referred to the *CELLEPORIDÆ*, unless it be found desirable to separate into a distinct family the recent forms of the type of the two last genera, and of which there are also a few fossil species described under *Vincularia* and others.

Of the *CELLARIIDÆ*, as here understood, there are two genera represented in the South Indian cretaceous deposits, each by a single species.

Salicornaria, Cuv., 1817.

Colony ramose, composed of flustrine cells round an imaginary axis of cylindrical branches, which are connected with each other by horny filaments; the joints are always attenuated at their base, and in adult colonies sometimes permanently anchylosed. Each cell is usually provided with an avicularian opening above the aperture, which is sub-anterior or sub-central.

Species of *Salicornaria* occur from the cretaceous period up to the present time.

Planicellaria, d'Orbigny, 1850.

Colonies ramose, dichotome, branches articulated, slightly compressed, with two alternate series of flustrine, strongly margined cells on the two opposite broader sides, and an undulating series of small, tumid avicularian cells on each of the narrower sides.

There appears to be only a single cretaceous species of this genus known, as will presently be noticed in more detail.

X. SALICORNARIA, *Cuvier*, 1817, (see above).

1. SALICORNARIA LAUTA, *Stoliczka*, Pl. II, Figs. 9–11.

Sal. ramulis rotundatis, simplicibus, basi sensim attenuatis, lævigatis, ad terminationem perforatis; cellulis in seriebus longitudinalibus numerosis dispositis, elongate sub-hexagonis, parte inferiore conspicuiter contractis, lævigatis, marginibus unitis, plus minusve acute elevatis, circumdatis; apertura antica, elongate ovata, simplici, haud distincter marginata.

The single joints appear to be rather short, each is attenuated towards the base, and at the termination perforated, having evidently been attached by a flexible fibrous string to a preceding joint. The number of longitudinal series of cells varies according to the age and respective thickness of each stem, usually it falls between eight and twelve. Each cell is somewhat elongately hexagonal, rather contracted in the lower half, smooth, and surrounded with a more or less elevated margin, which is common to the adjoining cells. The aperture is ovate and slightly sunken. Ovicells placed above the aperture have in very few instances been observed.

Locality.—Yermanoor, in a soft yellowish sandstone.

Formation.—Arrialoor group.

XI. *Genus.*—PLANICELLARIA, *d'Orbigny*, 1851, (see p. 23).

1. PLANICELLARIA OCULATA, *d'Orbigny*, Pl. II, Figs. 7–8.

1851. *Planicellaria oculata*, d'Orbigny, Pal. franç., terr. cret., vol. v, p. 37, pl. 653, figs. 1—5.
" ? " *fenestrata*, " " " " " " " 6—9.

Pl. ramulis compressiusculis, lateraliter anguste obtusis; cellulis ellipticis, incrassatis, sulcis levibus indistinctis separatis, medio apertura parva, ovata, perforatis; avicularii parvis, plus minusve tubulose projicientibus, uno lateri mediano externo singulæ cellulæ opposito.

Cellulis erosis apertura permagna elongata instructis (P. fenestrata, d'Orb.).

I have only two fragments of this remarkable species before me. They evidently represent one and the same species. One (fig. 8) is better preserved, and its cells agree with those of d'Orbigny's *P. oculata*, being surrounded by a kind of swelling of an elliptical shape, in the middle perforated by a comparatively small ovate aperture, and separated from each other by slight smooth depressions. The avicularia, placed laterally opposite the middle of the external lateral margin of each cell, are only slightly prominent, and with round openings.

The other fragment is evidently much worn on its surface, more so on one than on the other side; nearly the whole of the swollen portion of the cells round the aperture is broken in, and thus the stem attains an entirely different aspect, being at the same time also apparently flatter than the other one. In this stage the branch is almost identical with d'Orbigny's *P. fenestrata.* There can be no doubt that the two forms merely represent differently preserved stems belonging to the same species, and as d'Orbigny gives an exactly corresponding difference between his *P. oculata* and *fenestrata,* I must only conclude that they belong with the greatest probability to one and the same species. D'Orbigny's specimens also were from one and the same locality, the Senonien beds in the neighbourhood of Néhou (Manche), and he adds that the species is rare. I may state the same of its occurrence in India.

Locality.—Yermanoor, in a yellowish soft sandstone.

Formation.—Arrialoor group.

II. Order. CYCLOSTOMATA. (See ante p. 4).

In addition to the few species to be described in more detail, I may notice that fragments of a *Truncatula* (fam. *FASCIPORIDÆ*), of a *Crisina*, and an *Idomonea* (fam. *IDOMONEIDÆ*) have occurred, the former resembling *C. lichenoides*, (Goldf.), and the latter *I. communis*, d'Orb., but these fragments are not sufficient for an approachingly correct specific determination; they are all from the sandy beds at Yermanoor.

4. *Family,—CERIOPORIDÆ.*

(*CAVIDÆ*,* d'Orbigny; in part).

Cells tubular, equal, more or less elongated, terminating on every portion of a freely exposed surface, with closely set, rounded or sub-polygonal, generally slightly immersed, but never tubularly raised, orifices. The colonies are of very different shape, incrusting, globular, or ramose, and the cells are continuous in length, or they rest in distinct layers one over the other.

The principal character lies in the equal size of the orifices of the cells, which are placed close to each other; this is common to all the species belonging to the family, while the form and structure of the colonies can be used for the definition of genera. Of those which d'Orbigny referred to the family, a few have, however, to be excluded, namely, the species which he designates as *Sulcicava*, *Reticava*, *Letericava*, &c., and which unquestionably belong to the *IDOMONEIDÆ*. As regards the relation of the *CERIOPORIDÆ* to the *CEIDÆ*, I am unable to form an exact opinion, because I am not acquainted with any of the species of the latter family, but it seems to me that the two are entirely distinct, and that the *CEIDÆ* should be classed next to the *MYRIOZOIDÆ* and *ELEIDÆ*, as a family intermediate in some respects between the CHEILOSTOMATA and the CYCLOSTOMATA. Only a single Cerioporid genus, with a solitary species, has as yet been found represented in the South Indian cretaceous deposits.

XII. *Genus.*—CERIOPORA, *Goldfuss*, 1826.

Colonies attached to foreign substances by the base of subglobular or shortly ramose stems with subcylindrical branches; cells continuous throughout the stem, or in imperfectly superposed layers, apparently arising from a partial irregularity in the growth of the length of some cells; orifices close together, rounded, or very nearly so, slightly immersed and separated by a smooth surface.

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* I am not certain that d'Orbigny's genus *Cava* is really distinct from *Ceriopora*, and would, therefore, prefer using Busk's name for the family.

The *Cerioporæ*, of which Goldfuss' *C. micropora* from the Senonien of Maastricht may be considered the type, are exclusively found fossil, in jurassic, cretaceous and tertiary strata. It is usually stated that the colony consists of numerous superposed layers, but this is, strictly speaking, not the case. The tubular cells are continuous in each branch, but as they gradually, or at short intervals, increase in length all round on the surface, and thus enlarge the mass of the colony, the different stages of growth on the respective levels attain a similarity to distinct layers, one incrusting the other, but these two kinds of growth differ essentially from each other. The similarity between the stages of growth and the different layers is increased by the circumstance, which occasionally happens, that the growth of certain portions of the colony are arrested, while others proceed in a regular way, but they do not extend over the arrested parts of the colony. Defined in this manner, the genus *Ceriopora* must include many more species than were admitted to it by d'Orbigny.

1. CERIOPORA DISPAR, *Stoliczka*, Pl. III, Figs. 1–3.

Cer. colonia repente, cæspitosa vel ramosa, ramulis claviformibus aut plus minusve elongatis, teretibus, vel lateraliter compressiusculis; orificiis magnis, subrotundatis vel polygonis, immersis, interspaciis paulo angustioribus, convexiusculis, lævigatis aut minutissime obsoleteque puncticulatis, separatis, nonnunquam in seriebus obliquis fere regularibus dispositis.

The large size and regularity in the arrangement of the orifices distinguishes this species from all others at present known. The colonies generally form expanded layers, from which shorter or longer, rounded or slightly compressed branches issue, and these again appear to be ramified. On a well preserved surface the orifices lie between slightly elevated and narrower interspaces, but when these become worn off and are flattened, their width often equals to, or even slightly exceeds, the diameter of the orifices, and their surface exhibits a fine puncticulation.

Locality.—Poodoopolliam, in a pinkish somewhat sandy limestone.

Formation.—Arrialoor group.

5. *Family,—CRESCIDÆ.*

(*Crescidæ*, d'Orbigny, *Caveidæ*, d'Orb., part).

Colonies variable in shape and size, cells tubular, of two kinds, irregularly placed between each other, and terminating on all exposed portions of a colony. The larger, or ordinary, cells have rounded, often slightly elevated or margined, orifices, sometimes *arranged in groups, but without any regularity, while the smaller orifices are always somewhat immersed and interposed between the others.*

The *Crescidæ* answer exactly to the *Cerioporidæ*, differing from the latter by the cells being of larger and smaller size, both interspersed between each other. Whether all the generic divisions which are introduced in it by d'Orbigny are admissible I am not in a position to affirm; but I believe that most of the species of *Zonopora*, and its close allies, which are placed by d'Orbigny in a distinct family, *Caveidæ*, should not be separated from the *Crescidæ*, because they have smaller orifices placed between the larger ones, even when the latter only occur on limited portions of the stem. The name *Caveidæ* ought, I think, to be retained for those genera in which the larger cells are arranged in regular series, as, for instance, in *Cavea*, *Domopora*, *Radiopora*, *Stellipora*, &c.

However, some of the genera with the larger orifices arranged in bundles, or in multiserial ridges, as in most of the discoid *Defranciæ*, *Buskia* of Reuss, and others, and also nearly the entire family *Cytidæ* of d'Orbigny, should be united with the *Fasciporidæ*, or *Fasciгeridæ*, whichever name may be thought preferable. I have little doubt that with these changes, if adopted, and also those I have alluded to, when speaking of the two previous families, a more rational grouping into families of the inarticulate CYCLOSTOMATA might be attained. Of course d'Orbigny's division of the latter order into '*Foraminata*, *Tubulata*, and *Fasciculata*' must be given up; for it is irreconcileable with that author's own, and, I believe, also with any other, classification that may be proposed.

Two genera, each with a single species, have been met with in the cretaceous deposits of Southern India.

Heteropora, Blainville, 1834.

Colonies simple, or ramose, with cylindrical or slightly clavate branches, attached by the base to foreign objects. Larger and smaller orifices irregularly distributed over the entire surface of the colony.

The species of this genus are found in meso- and cæno-zoic deposits, and there also occur a few species recent in the Eastern seas.

Zonopora, d'Orbigny, 1849.

Colonies ramose, as in *Heteropora*, but the larger orifices only occur in groups or on slightly elevated zones round the cylindrical or somewhat compressed stems; there is, however, no regularity observed in their position respecting each other, and smaller orifices are intermixed between them, and also occur on the intermediate portions of the groups or zones.

Thus *Zonopora* may be looked upon as a combination of *Ceriopora* and *Heteropora*. Some of the species very closely resemble *Plethopora*, which only differs by the absence of smaller orifices interspersed between the larger ones.

The genus is met with chiefly in cretaceous deposits, but it is also, though very rarely, represented in tertiary strata.

XIII. *Genus.*—HETEROPORA, *Blainv.*, 1834, (see p. 27).

1. Heteropora Tamulica, *Stoliczka*, Pl. III, Fig. 4.

H. colonia ramosa, ramis dichotomis, cylindraceis; cellularum aperturis subtubulosis, plus minusve irregulariter sparsis, ostiolis numerosissimis, nonnullis paululum elongatis atque in seriebus indistinctis longitudinaliter undulatis dispositis.

Branches dichotom and cylindrical, with the orifices of the cells round, moderately projecting above the surface of the stem, and with very numerous interspersed small pores, many of which are slightly elongate and connected into more or less distinct, longitudinally undulating, series. On some portion of the branches the apertures of the cells have sometimes a disposition to arrange themselves in transverse series, but in other places there is no regularity to be observed in the arrangement. In the centre of the stem, the cells are, as usually, irregularly arranged, curving outwards to each side, and as they are much more delicate in the centre than round the surface, they are easily broken in at the terminations of the stems, which then have the appearance of d'Orbigny's *Semicrescis* or Hagenow's *Cavaria.* The species belongs to the same type as Hagenow's *H. Dumonti* (Bryoz. Maast. Kreide., p. 48), differing from it by the apertures being closer together, and also a little larger, as are likewise the intermediate pores.

Locality.—Yermanoor, in yellowish soft sandstone.

Formation.—Arrialoor group.

XIV. *Genus.*—ZONOPORA, *d'Orb.*, 1849, (see p. 27).

1. Zonopora indica, *Stoliczka*, Pl. III, Fig. 5.

Zon. colonia ramulis crassis, ad intervalla brevia contractis atque in utroque latere obtuse tuberosis, in partibus elevatis orificiis majoribus atque minoribus, rotundatis, dense intermixtis instructis.

A single fragment of this form differs from the several allied species described by d'Orbigny by the obtuse protuberances being conspicuously more developed in two opposite directions, so as to give the branch a slightly compressed appearance and a broadly elliptical section. The protuberances are larger and more widely separated than in *Zon. undulata*, which in other respects the Indian species closely resembles. The orifices are, strictly speaking, of three kinds: those in the contracted portions are of medium size, all equal or subequal, and separated from each other by interspaces, which are as broad as the diameter of each orifice. On the elevated portions the large round orifices are separated by smaller ones, which, again, differ in size, some of them equalling those in the depressions and others are still smaller.

The cells in the centre of the stem are vertical, and those adjoining them gradually bent out towards the margins.

Locality.—North of Poodoopolliam, in a whitish limestone.

Formation.—Arrialoor group.

6. *Family,—ENTALOPHORIDÆ.*

Pustuliporidæ, auct., in part. *Sparsidæ*, d'Orb., in part.

Colonies ramose, attached only by the base of the stem to foreign objects, or creeping on the same; cells tubular, irregularly distributed over the surface, and, as a rule, without any intermediate, or accessory, pores.

Those CYCLOSTOMATA which have the cells provided with tubular, projecting orifices appear to be rationally divisible into three families: 1, the *Entalophoridæ*, as above characterized; 2, the *Idmoneidæ*, in which the orifices are arranged in regular rows, either all round a branch, or only on one or two sides (*Idmonea*, *Hornera*, *Spiropora*, &c.); 3, the *Fasciporidæ*, in which the cells are arranged in more or less regular groups (*Cyrtopora*, *Actinopora*, &c.). An epitheca appears to be always present on the stems, but whether it is solid or provided with intermediate pores between the regular cells cannot be looked upon of higher than generic value, as is, for instance, the case between *Idmonea* and *Crisina*, or between *Spiropora* and *Spiroporina*, and others. The presence of the superficial pores appears to depend upon that of certain longitudinal canals, which surround each tubular cell, and the signification of which is as yet unknown. The numerous family divisions introduced by d'Orbigny in his section '*Tubulata*' are untenable.

Of several of the genera belonging to the present family, I have given a review in my fossil Bryozoa from New Zealand (Comp. Reise der Oest. Fregatte Novara, Geol. Theil, 1st Band, 1865, p. 97 et seq.). In the South Indian cretaceous deposits only two have as yet been found, each being represented by two species.

Proboscina, Audouin, 1826.

Colonies creeping on foreign objects, permanently attached in narrow, branched, single, and more or less elevated or convex layers. The species of this genus are most numerous in jurassic and in cretaceous deposits.

Entalophora, Lamx., 1821.

Colonies erect, ramose, attached with the base to foreign objects; branches cylindrical or slightly compressed; orifices of the aperture irregularly disposed all round the stems.

The *Entalophoræ* mostly occur in cretaceous deposits, but are also represented both in the jurassics and in the tertiaries, as well as in the present seas. I have elsewhere (Novara Reise, loc. cit., p. 101,) discussed the propriety of adopting the name *Entalophora* in place of that of *Pustulopora* of Blainville, and although several authors still retain the latter name in preference to the older one, I do not see the least change in the arguments which I then produced.

In the same paper I have adopted d'Orbigny's name *Bidiastopora* in a somewhat different sense from the original characteristic given of the genus, namely, retaining it for a certain number of *Entalophoræ* with slightly compressed branches. Some of these forms had been referred already by d'Orbigny to his *Bidiastopora*, but its typical species differ essentially by having a solid lamina passing through the centre of the branches. On reconsidering this question, I find that the latter, namely, the typical *Bidiastopora* of d'Orbigny, must be again united with *Mesenteripora*, because the slightly smaller or greater compression of the branches (which are very broad and cespitose in typical *Mesenteripora)* cannot be considered as a character of generic value. On the other hand, the species which only differ from typical *Entalophoræ* with cylindrical branches by having them slightly compressed, and for which I then believed that the name *Bidiastopora* might be retained, must be referred to *Entalophora*. It might be that the name *Bidiastopora* is still admissible for some of the species referred by d'Orbigny to it, but of which from mere figures it is at present difficult to judge whether they belong to the cheilostomate or to the cyclostomate division of the Ciliopoda, and this question must, therefore, be left to further research for settlement.

XV. *Genus.*—PROBOSCINA, *Audouin*, 1826, (p. 29).

1. Proboscina radiolitorum, *d'Orbigny*, Pl. III, Fig. 6.

1851. *Proboscina radiolitorum*, d'Orb., Pal. Franç. terr. cret., v. p. 854, pl. 633, figs. 8-10.
1854. „ „ „ Reuss in Denksch. Akad., Wien, vol. vii, pt. I, p. 137, pl. xxvii, fig. 14, and pl. xxviii, fig. 7.

Prob. colonia ramis dichotomis seu partim confluentibus, latis, convexis, ad terminationes nonnunquam claviformibus; cellulis tubulosis haud distincter separatis, lævigatis, orificiis modice elevatis, approximatis, in seriebus obliquis, transversis, plus minusve regularibus dispositis.

The characteristic distinction of this species consists in the apertures of the cells being arranged in more or less regular transverse series, in each of which they are more closely placed to each other, than is the distance between two adjoining cells in a longitudinal direction. Sometimes the orifices in one of these cross series become almost confluent; this is, however, only the case when their tubular terminations have been broken off. The form of the colony is very variable, sometimes single, or dichotome, or several branches become more or less confluent, but in all the same arrangement in the cells and the same size of the orifices is to be observed.

Locality.—North of Poodoopolliam, incrusting shells of *Terebratula subdepressa*, Stol., not common.

Formation.—Arrialoor group.

D'Orbigny described the species from the Turonien bed of 'Pons (Charente-Inferieure),' from 'Angoulême (Charente) and from Sainte-Maure (Indre et Loire).' Prof. Reuss found it in the Gosau-deposits of the Alps and in the Plæner limestone of Bohemia.

2. Proboscina angustata, *d'Orbigny*, Pl. III, Figs. 7–8.

1851. *Proboscina angustata*, d'Orb., Pal. Franç. terr. cret., v, p. 852, pl. 632, figs. 7-9.

Pr. colonia angusta, ramosa, paulo convexinscula, cellulis tubulosis, plus minusve elongatis, plerumque in duabus seriebus, fere regularibus el alternantibus, dispositis, lævigatis, minutissime puncticulatis; orificiis modice elevatis atque ad utrumque latus ex-curvatis.

The colony is narrow and generally dichotome, the branches being of nearly equal thickness throughout, composed of alternating series of tubular cells, with the orifices bent outwards on each side. In well preserved specimens, which have the cells nearly perfect, the orifices are rather distant, and their alternating position is tolerably well marked, (*see* fig. 8), but when the surface becomes worn off, this regularity is less conspicuous, the cells appear to be shorter, and the orifices are sometimes placed nearly side by side. The alternating regularity is also less observable on sharply bent portions of the colony, or at the terminations of single branches.

On the whole, there is, however, no essential distinction between European and Indian specimens.

Locality.—North of Poodoopolliam; found creeping on *Terebratula subdepressa*, Stol.; rare.

Formation.—Arrialoor group.

D'Orbigny described his specimen from 'Mans (Sarthe)', found in beds believed by him to be referable to Cenomanien, or the Craié chloritée.

XVI. *Genus.*—ENTALOPHORA, *Lamouroux*, 1821, (see p. 29).

1. Entalophora lineata, *Beissel*, Pl. III, Figs. 9–10.

1865. *Entalophora lineata*, Beissel, Bryozoen Aachner Kreideb., Haarlem, p. 80, pl. ix, figs. 116—119.

Ent. colonia ramulosa, ramulis gracilibus, sub-cylindricis, cellulis tubulosis in quatuor aut quinque seriebus alternantibus circa peripheriam dispositis, lævigatis, in superficie longitudinaliter lineatis; orificiis plus minusve tubulose projicientibus atque lateraliter curvatis.

The branches are in this species thin, and almost round and cylindrical, being slightly widened only near the orifices. The cells are moderately elongate, in four or five alternating series, smooth, with opaque longitudinal lines. In well preserved specimens the orifices are distinctly tubular and bent outwards, but the margins are easily broken away, and then the form of the apertures changes from round to an oval shape.

Beissel, who studied the internal structure of this and other allied species, states that the longitudinal lines are produced by fine canals which surround each cell, and some of which are more or less continuous through the entire length of a branch.

Locality.—Yermanoor, in yellowish sandstone; rare.

Formation.—Arrialoor group.

Beissel gives it as a rare species, occurring in the Chalk without flints at Friedrichberg, Preusberg, and Vaels, all localities in the Senonien beds near Aachen.

2. ENTALOPHORA PAVIMENTATA, *Stoliczka*, Pl. III, Fig. 11.

Ent. ramis crassiusculis, sub-cylindraceis, cellulis in superficie deplanatis, minutissime puncticulatis, lineis paululum elevatis in utroque latere marginatis, aperturis terminalibus, sub-rotundatis, vix prominentibus, aut sparsis, aut partim in seriebus obliquis dispositis.

This species differs from the majority of those known by the cells being depressed, flat, or very little convex, and surrounded by slightly elevated lines, most conspicuous on either side of the cell. The surface is very minutely punctated. The apertures on the stem are numerous, very slightly or not at all prominent, somewhat rounded, and in some places arranged in oblique rows, but more generally they appear to be irregularly disposed. The section of the branch is nearly cylindrical, and shows an almost gradual increase in the diameter of the cells from the centre towards the periphery.

Locality.—Yermanoor, in yellowish soft sandstone; very rare.

Formation.—Arrialoor group.

GENERAL REMARKS ON THE CILIOPODA OF THE SOUTH INDIAN CRETACEOUS DEPOSITS.

The Ciliopods are represented by a comparatively very small number in the South Indian cretaceous deposits, and their distribution is very local. There are eleven genera of Cheilostomata, with altogether only seventeen species, and eight genera of Cyclostomata, with only ten species; however, as four of the species do not admit of more than a generic determination, the total number of satisfactorily determinable species is twenty-three, which is slightly larger than that of the Brachiopoda, but very much less than that of any of the three other classes of Mollusca previously dealt with.

There are only six localities which have yielded specimens of Ciliopods at all, and of these merely three, which furnished more than one. All the localities fall within the geographical extent of the Arrialoor group, which corresponds to the Upper Chalk, part of Turonien, Senonien and Danien, or Upper Plæner of European geologists, as will be seen from the following tables :—

No.	Name.	Page.	Plate.	Figure.	Locality	Geological Group	Geological position in other countries.
					in Southern India.		
	CHEILOSTOMATA—						
	CELLEPORIDÆ—	5					
I	CELLEPORA—	6					
1	„ *prona*, Stol. ...	12	I	1	Poodoopolliam ...	Arrialoor group.	
2	„ *puncticulata*, Stol. ...	12	I	2	Chokonadapooram ...	„	
3	„ *incipiens*, Stol. ...	13	I	3	Poodoopolliam ...	„	
4	„ *miselis*, Stol. ...	13	I	4-5	Poodop. & Chokonadap.	„	
II	ESCHARA—	7					
5	„ *spectabilis*, Stol. ...	14	I	6-7	Ootacoil ...	„	
6	„ *perigera*, Stol. ...	15	I	8	Chokonadapooram ...	„	
III	ESCHARIPORA—	8					
7	„ *ortiva*, Stol. ...	15	I	9	Yermanoor ...	„	
8	„ *ominosa*, Stol. ...	16	I	10	Poodoopolliam ...	„	
IV	CELLEPORARIA ? sp. ...	16	I	11	Chokonadapooram ...	„	
V	DISCOPORA—	9					
9	„ *abjecta*, Stol. ...	17	I	12	Yerman. & Chokonadap.	„	
VI	MEMBRANIPORA—	10					
10	„ *pedata*, Stol. ...	17	II	2-3	Kinnyoor ...	„	
11	„ *auriculata*, Stol. ...	18	II	4	Poodoopolliam ...	„	
VII	ESCHARINELLA—	10					
12	„ *discors*, Stol. ...	18	II	1	Yerm., Chokonadap., Ootac.	„	
VIII	BIFLUSTRA—	11					
13	„ *cingulata*, Stol. ...	19	II	6	Yermanoor ...	„	
	SELENARIIDÆ—	19					
IX	LUNULITES—	20					
14	„ *annulata*, Stol. ...	22	II	5	Comarapolliam ...	„	

No.	Name.	Page.	Plate.	Figure.	Locality	Geological Group	Geological position in other countries
					in Southern India.		
	Cellariidæ—	23					
X	Salicornaria—	23					
15	„ *lanta*, Stol.	23	II	9-11	Yermanoor ...	Arrialoor group.	
XI	Planicellaria—	23					
16	„ *oculata*, d'Orb. ...	24	II	7-8	Yermanoor ...	„	Néhou (Manche), Senonien beds of France.
	CYCLOSTOMATA—						
XII to XIV	Truncatula, Idmonea, and Crisina, sp. ind.	25					
	Cerioporidæ—	25					
XV	Ceriopora—	25					
17	„ *dispar*, Stol. ...	26	III	1-3	Poodoopolliam ...	„	
	Cerieidæ—	26					
XVI	Heteropora—	27					
18	„ *Tamulica*, Stol. ...	28	III	4	Yermanoor ...	„	
XVII	Zonopora—	27					
19	„ *indica*, Stol. ...	28	III	5	Poodoopolliam ...	„	
	Entalophoridæ—	29					
XVIII	Proboscina—	29					
20	„ *radiolitorum*, d'Orb. ...	30	III	6	Poodoopolliam ...	„	Turonien beds of France, Bohemia, and the Alpine Gosau deposits.
21	„ *angustata*, d'Orb. ...	31	III	7-8	Poodoopolliam ...	„	? Cenomanien of 'Mans (Sarthe).'
XIX	Entalophora—	29					
22	„ *lineata*, Beiss. ...	31	III	9-10	Yermanoor ...	„	Senonien near Aachen.
23	„ *pavimentata*, Stol. ...	32	III	11	Yermanoor ...	„	

It is natural that with such a limited distribution of the species, and comparatively very great scarcity of even the specimens, no geological inference can be drawn regarding the relation of the different groups of the Trichinopoly and South Arcot deposits among themselves. Of the twenty-three species found in the Arrialoor group four are identical with those from European upper cretaceous deposits. This gives 17 per cent. for the Ciliopoda, the next largest percentage of identical species, after the Brachiopoda and the Cephalopoda.

PLATE I.

Fig. ... 1. CELLEPORA PRONA, *Stoliczka*, p. 12; a small portion of a colony enlarged about forty diameters; *N. of Poodoopolliam, Arrialoor group.*

Fig. ... 2. CELLEPORA PUNCTICULATA, *Stoliczka*, p. 12; a portion of a colony enlarged about twenty diameters; *Chokanadapooram, Arrialoor group.*

Fig. ... 3. CELLEPORA INSIPIENS, *Stoliczka*, p. 13; enlarged portion of a colony; *N. of Poodoopolliam, Arrialoor group.*

Figs. 4—5. CELLEPORA MISSILIS, *Stoliczka*, p. 13; enlarged portions of two different colonies: in fig. 4, the ovicells are nearly everywhere, in fig. 5, scarcely at all, developed; *N. of Poodoopolliam, Arrialoor group.*

Figs. 6—7. ESCHARA OPTABILIS, *Stoliczka*, p. 14; 6, enlarged portion of a rounded stem, represented in natural size in fig. 6*a*, its lower part is round, as shown in section 6*b*, the upper is somewhat compressed; 7, 7*a*, 7*b*, are corresponding figures of another more distinctly foliaceous colony; *Ootacoil, Arrialoor group.*

Fig. ... 8. ESCHARA PORIGERA, *Stoliczka*, p. 15; 8, enlarged portion of a colony, 8*a*, the same of a section; *Chokanadapooram, Arrialoor group.*

Fig. ... 9. ESCHARIFORA ORTIVA, *Stoliczka*, p. 15; 9, enlarged portion of the stem represented in fig. 9*a*, 9*b*, is the section of fig. 9; *Yermanoor, Arrialoor group.*

Fig. ... 10. ECHARIFORA OMINOSA, *Stoliczka*, p. 16; 10, enlarged portion of a small stem represented in fig. 10*b*, 10*a* is an enlarged section of the same colony; *N. of Poodoopolliam, Arrialoor group.*

Fig. ... 11. CELLEPORARIA *sp. indet.*, p. 16; side and top views of a stem in natural size; *Chokanadapooram, Arrialoor group.*

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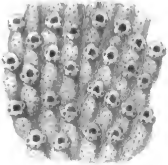
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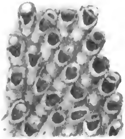
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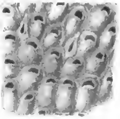
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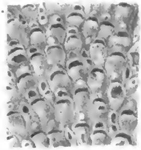
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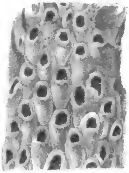
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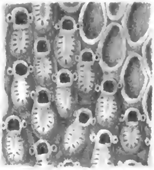
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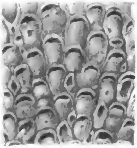
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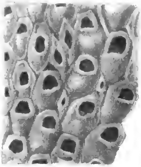
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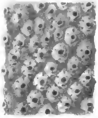
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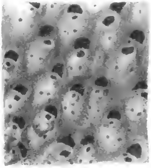
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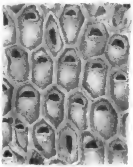
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PLATE II.

Fig. ... 1. Escharinella discors, *Stoliczka*, p. 18; enlarged surface of a foliated stem; *Yermanoor, Arrialoor group.*

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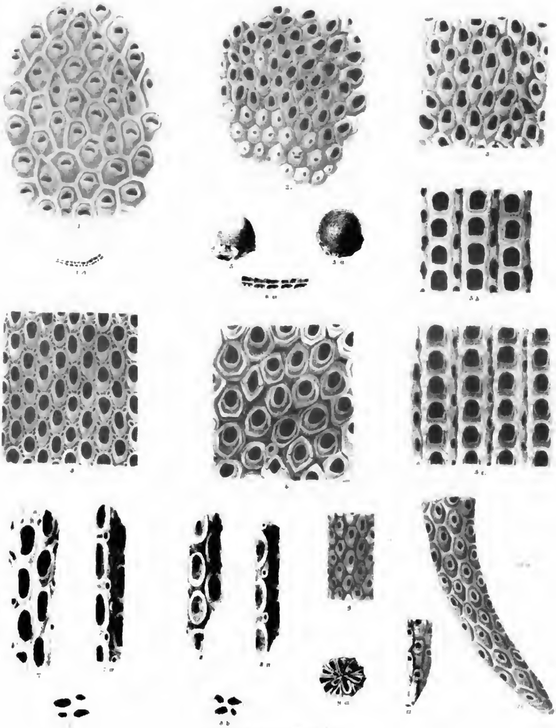
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PLATE III.

Figs. 1—3. Ceriopora dispar, *Stoliczka*, p. 26; 1 is a short enlarged stem of 1*a*; 2 is a portion of a longer branch; 2*a*, a portion of the same enlarged; and 2*b*, half of the section, showing the gradual increase in the width of the cells; 3 is a piece of rock with a portion of a spreading colony and the base of one branch which had been broken off; 3*a* is an enlarged surface of the former, and 3*b*, an enlarged section of the latter; *Poodoopolliam, Arrialoor group.*

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Fig. ... 6. Proboscina radiolitorum, *Orbigny*, p. 30; 6, the creeping colony in natural size; 6*a*, a few branches enlarged, in order to show the distribution of the cells; 6*a*, lower figure, a small portion of one branch, still more enlarged; *N. of Poodoopolliam, Arrialoor group.*

Figs. 7—8. Proboscina angustata, *Orbigny*, p. 31; 7, a creeping colony in natural size, 7*a*, enlarged, the cells had their apertures much injured and the surface is not well preserved; 8 and 8*a* are corresponding figures of a better preserved small colony; *N. of Poodoopolliam, Arrialoor group.*

Figs. 9—10. Entalophora lineata, *Beissel*, p. 31; side and sectional views of portions of two stems; *Yermanoor, Arrialoor group.*

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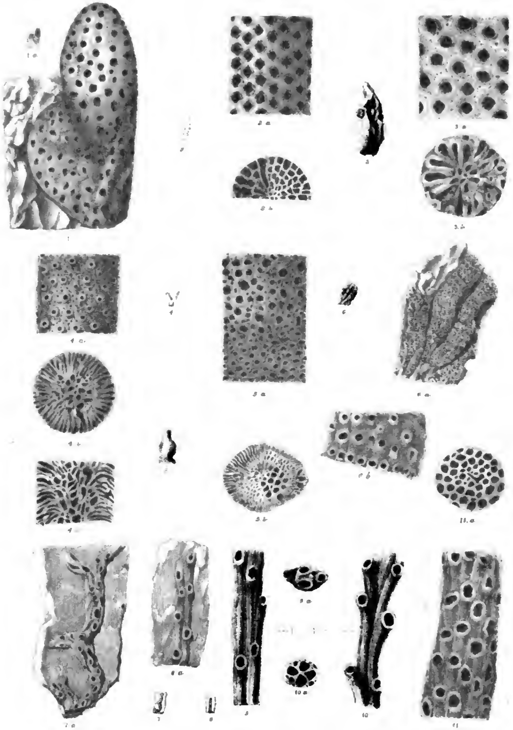

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Echinodermata

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MEMOIRS

OF THE

GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

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CRETACEOUS FAUNA OF SOUTHERN INDIA.

Vol. IV. 3.

Ser. VIII. 3. The ECHINODERMATA, by Ferd. STOLICZKA, Ph. D., F. G. S., &c., &c.,

Palæontologist, Geological Survey of India.

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INTRODUCTION.

THE Actinozoa, which form a separate sub-kingdom,- characterized by having their organs disposed in radii which are four, five, six, or a multiple of these numbers, and by possessing a special opening leading to a digestive cavity,- are represented in the South Indian cretaceous deposits by two classes, the Echinodermata and the Corals, or Anthozoa, the former of which are the subject of the present article.

Few other classes of animals can compete with the Echinodermata in the zoological and geological interest which attaches to their study. The intimate relation, which exists between the soft and the solid parts of the animal, makes them particularly fit for tracing out the gradual changes which have taken place in the development of the class in successive periods up to the present time. Of course, the short monograph here given cannot be of any very great importance in regard to this general subject, but it has its little value in making us acquainted with the remains of about twenty-three new species, in addition to a few others which had been already described by the late Prof. Forbes and M. D'Orbigny, and in aiding to define the age of the different upper cretaceous beds in the Trichinopoly and South Arcot Districts of South India.

MONOGRAPH OF THE ECHINODERMATA

OF THE

CRETACEOUS DEPOSITS IN SOUTH INDIA.

Sub-kingdom, ACTINOZOA.

Class, ECHINODERMATA.

As one of the three (or perhaps five) principal divisions of the Actinozoa, the Echinodermata include the highest organised forms of the Radiate group of the animal kingdom; they are marine animals, free or sessile, or sometimes fixed by an articulated stem, mostly covered with hardened integument composed of single coriaceous particles, or calcareous plates. The form of the body varies from discoidal to hemispherical, or globose and cylindrical, with or without appendages which indicate the general radiate structure. These arms, or other appendages, have a more or less developed prehensile property; they can generally be re-produced; and the integument is besides often pierced with pores, through which certain pedicells or other kind of cilia are protruded, and serve as organs of locomotion. An oral opening, surrounded by a central nerve-organ, a vascular system, &c., are always present; the sexes are mostly distinct, and the young Echinoderm undergoes certain stages of metamorphosis, before it becomes fully developed.

Few other classes of a well defined larger group of animals show greater diversity, both in a purely anatomical as well as morphological point of view, than do the Echinodermata. This circumstance, coupled with the comparatively great facilities with which their integuments are preserved in a fossil state, made the recent as well as the extinct Echinodermata an object of early study, and the interest attached to their organisation has occupied the attention of some of our best anatomists and morphologists. But it would be far beyond the scope of the present Memoir to enter into a detailed account of the whole class, because only a comparatively very small portion of it finds representatives in the South Indian cretaceous deposits.

The whole class is somewhat differently sub-divided by various authors. The most usually adopted classification is that into *Holothurioidea*, *Echinoidea*, *Asteroidea*, *Crinoidea*, and *Blastoidea*. Detailed descriptions of the different orders will be found in Dujardin and Hupes' *Nouv. Suite à Buffon*, Bronn's *Klassen* and *Ordnungen des Thierreiches*, and other general zoological works. Dr. Wright, who promises to give a comprehensive account of the class at the conclusion of his work* on the British cretaceous Echinodermata, adds to the five orders, above referred to, the *Sipunculoidea*, and separates the *Ophiuroidea* from the *Asteroidea*, and the *Cystoidea* from the *Crinoidea*.

Three orders of the Echinodermata are represented in South India. The *Crinoidea* by two or three species, the *Asteroidea* by a single one, and the *Echinoidea* by thirty-eight. As the last includes the most highly organised types, I will, according to the general arrangement adopted in these monographs, begin the description with the *Echinoidea;* and as this is at the same time the only order of which a considerable variety of species has to be noticed, and as more extensive discoveries of Echinoids in the South Indian cretaceous deposits are certainly to be expected, I will preface the detailed descriptions by a brief anatomical account, giving also an abstract of the general classification.

I. Order. **ECHINOIDEA.**

General Character.—*Echinoderms with an oval, or round, or polygonal, more or less spheroidal or depressed, free body, surrounded by twenty or more ranges of polygonal calcareous plates, closely fitting against each other; ten of these ranges, called the ambulacra, are always provided with continuous or interrupted series of pores for the passage of retractile pedicells, while the outer surface of all is covered with more or less distinct granules or tubercles to which calcareous spines of various shapes are articulated; mouth inferior, central or excentric, internally sometimes provided with a complicated masticatory apparatus; anus very variable in position, above central or excentric, or marginal, or below excentric; three to five genital and five ocular plates always form the apex, the madreporiform plate is united with the right anterior genital; the sexes are distinct.*

This general character referring to the test requires some explanation, in order to show which points should particularly be consulted in the determination of species and genera; and as the internal organisation is intimately connected with that of the solid test, this being very variable in structure and form, it might be useful here briefly to allude to the principal anatomical points; this will also indicate the importance which can be attached to the different parts of the test to be described immediately.

As regards the form of the test, it may be remarked that in by far the majority of cases it is spherical or hemispheroid, round, or more or less ovate, in circumference, or sometimes with perforations near, or incisions at, the margin. The test is composed of five pairs of ambulacral, and alternating with the former five inter-ambulacral zones of plates, making a total of twenty meridional series; only in some of the palæozoic forms, the so-called Tesselati, this number of series rises to 35, and even to 75. The plates are joined to each other by plain sutures, firmly connected by organic substance, forming a solid test. In very few cases, as, for instance, in *Melonites*, is the number of ambulacral series larger than ten.

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The pedicellar pores in the ambulacra are either scattered, or generally they are situated near the outer basal margin of each plate, either in *continuous* or simple series, extending from the apex to the aperture *(Cidaris, Echinus)*; sometimes they become slightly less distinct with the distance from the apex, but the series are still continuous, or very nearly so *(Dysaster, Echinoneus)*; or the series of pores are *partially interrupted*, the two pores in each ambulacrum being well distinguishable on the upper side of the test, terminating abruptly before or when they reach the periphery, after which sometimes a few single pores are traceable, occasionally re-appearing again near the peristome of the aperture as a so-called *rosette;* the upper portion of this kind of poriferous series is called *sub-petaloid* (many *Hemiaster*, *Eupatagus*, etc.) Lastly, there are instances in which the poriferous zones become *entirely interrupted*, forming on the upper side round the apex five elongated, ovate, almost perfectly closed regions; this form is called *petaloid*, and is best marked in *Clypeaster* and its allies. As regards the pores themselves, composing the pair in each series, they are either equal and close together, or far apart, uni- or bi- or poly- geminal; the outer pores are sometimes larger and elongated, and again they are occasionally connected by a groove with each other, in which case they are said to be yoked. In the case of the petaloid or sub-petaloid form of the poriferous zones, these are situated in furrows or not. All these characters are of the utmost importance in classification. The form of the poriferous zones is mostly a family or sub-divisional character; the form and relative position of the pores is most useful in distinguishing genera, while the relative number of pairs of pores is generally very constant in different specimens belonging to the same species.

The surface of the test is ornamented with tubercles and spines, both of which are extremely variable. The tubercles when of large size are called primary; they are composed of the mamelon, which is the convex top part of the whole; the boss, or conical prominence, with a smooth or crenulated upper edge, and the areola, or excavated space, surrounding the boss. Smaller tubercles are called secondary, or minute, or when they are very small, they are designated granules, sometimes with similar gradations, as in the case of the tubercles. The tubercles are in the centre of the mamelon perforated or not. To the mamelon the spines, or radioles, are articulated, which vary from an almost globular to a cylindrical, club-shaped, or aciculate form. Both the radioles and tubercles are, like the remainder of the test, covered with an epidermis; their shape and relative size are important in specific distinctions; while the perforation of the tubercles is regarded to have a generic value, the distribution and size of the same, whether of equal or of different size on the various meridional zones of the test, etc., forms a sectional or family character.

The apex, or apical apparatus, forms the centre, from which the poriferous zones radiate; it lies centrally or excentric in the upper surface, sometimes it is lengthened to a considerable extent, (as in *Echinocorys).* This apical apparatus is composed of five, four, or three, perforated genital plates, which externally alternate with five ocular plates. The right anterior genital plate is generally grown together with the madreporiform plate; it is rarely firmly attached to any of the other genital or ocular plates. Accessory plates between the genital occur very rarely, as, for instance, in the *Salenidæ*. In the centre of the genital plates *(Cidaridæ)*, or only partially surrounded by them (some *Salenidæ)*, lies the anus; it is, like the apex, central, or entirely excentric, superiorly or inferiorly sub-terminal, or quite posterior, sometimes situated in a special furrow. The composition of the apical apparatus and the position of the anus are usually regarded as constant family characters, and when the latter is excentric, its situation very often forms a good generic character. Scarcely of less importance in point of classification is the position of the aperture, or the oral opening. It is almost always on the lower, flatter side, central or anteriorly excentric; in the former case with a simple or an incised, round or decagonal peristome; in the latter it is also round, pentagonal, or somewhat irregularly angular, or transversely ovate and bilabiate.

Both the anal and oral openings, although often for brevity's sake called anus and mouth, have, strictly speaking, not this signification. In the fresh animal they are covered with a soft or scaley or scutigerous buccal membrane, and in this lies the true mouth or anus. In some cases this buccal membrane is supplied with special strong muscles, and consists of several epithelial and pigment layers; in many *Cidaridæ* the ambulacral pores extend on it.

I have already noticed that the entire test, including the spines or radioles, is covered by the epidermis, and that in consequence of this, its structure is intimately connected with the inner organisation of the animal. The only internal organ, however, which occasionally remains preserved in a fossil state, is the masticatory apparatus, although it is present only in a portion of the Echinoids. It is best known under the name of Aristotle's lanterne, a conical highly complicated apparatus of solid plates and muscles and membranes. It is composed of five separate pyramids, each consisting of two elongately triangular, internally transversely striated, externally at the edge flattened, calcareous lamellæ, enclosing a long tooth between these flattened edges, at the base with a few other shorter solid pieces, which serve for the attachment of muscles, and give, so to say, a steadiness to the operation of the whole apparatus. The ends of the five teeth protrude a little from the mouth, which leads through an œsophagus to a short alimentary canal, generally with a thickened portion distinguished as stomach; the alimentary canal has two or more twists, and is attached to the inner walls of the test by numerous fine muscles. No special secretionary organs are known, and in many instances it is yet very doubtful what should be regarded as organs of respiration. Some of the Echinoidea have the peristome with two incisions in each inter-ambulacrum, and through these incisions certain branched organs are protruded, which are at least partially supplied with vessels, and, therefore, regarded as buccal gills. Other morphologists attribute to respiratory functions certain pedicells which are protruded through the ambulacral pores, and which are partly peculiarly shaped. These pedicells will be alluded to again hereafter. As, however, all these organs have only a limited extent, and are in some Echinoids entirely absent, it is commonly believed that respiration is maintained by the entire inner side of the body, the movement of the water which enters through the mouth being facilitated by the constant motion of the cilia of the inner ephithelium.

In connection with the respiration may be mentioned the peculiar aquiferous system, which is, as in the Asteroidea, of very considerable extent. It begins with the madreporiform plate, a finely porous calcareous disc, situated in or near the apex, and often grown to the right anterior genital plate. From the madreporiform plate leads a rather fine and thin dermal tube to the so-called circular canal, internally supplied with cilia and surrounding the œsophagus. Besides several smaller cellular enlargements, five long, again sub-divided arms branch off along the inner ambulacral walls and partially terminate in the pedicells, protruding through the ambulacral pores. These pedicells are generally peculiarly formed, with thickened, soft terminations, undulating at the margins. There are, however, many other kinds of pedicells round the mouth and on different portions of the body, some with globular ends, others branched, and again others with regular small suckers, supplied with numerous calcareous particles. They are believed to perform different functions, some being particularly destined as organs of the touch, others of locomotion, or for temporary attachment, etc. In addition to these there are the pedicellariæ, which appear to be special epidermal organs, consisting of a short stem and three terminal branches, which act as nippers; they are partially of solid structure, and probably intended as prehensile organs. They re-call the form of the so-called avicularia of the Ciliopods (Bryozoa).

The centre of the circulatory system of the blood is a heart, which is an elongated, somewhat twisted canal, situated near the œsophagus, above the jaws. It sends one anterior arterial branch towards the mouth, near which it forms a ring, sending off branches to the muscles of the lanterne and the other parts of the body, and posteriorly it receives a venous arm, which, after receiving through a capillary system the chylus from the intestines, conveys it to the respiratory epithelium of the inner walls of the body and then to the heart.

The nervous system consists of a ring round the œsophagus, from which five principal ambulacral nerves branch off, being again numerously sub-divided and supplying the other organs. Each of the branches terminate with a thicker ring, which, near the apex, lies in a hole of the so-called ocular plate, at the superior end of each ambulacrum. Although no lens was observed in these fibrous globular terminations, they are believed to represent eyes, and hence the name– ocular plates. Of the other senses, only touch is developed in the various soft appendages of the external, body particularly the pedicells.

The sexes appear to be always distinct. Both, whether ovaries or testes, consist, as far as observed, of five principal portions; in the hemispheroid forms their length varies. They are chiefly situated along the inter-ambulacra, forming greatly subdivided and branching glands. Each terminates with a pore in the so-called genital plate, of which there are in the regular forms of Echinoidea generally five, in the irregular group often four or three, while in some of the palæozoic Tesselati their number rises to fifteen. There is no external difference in the sexes, but internally the organs are of course very different as regards the elements of secretion. The testes are usually white, but the ovaries yellow, brown, pink, or of a bright red colour.

The development of the young begins with the ovum, and passes through a rather complicated metamorphosis. It has as yet been observed only in a few species of *Schizaster*, *Spatangus*, *Toxopneustes*, etc. The furcation of the yolk in the egg begins a few hours after fructification has taken place. After the first day the egg membrane breaks open, and the globular or oval embryo moves about with the support of its cilia, and shortly after the first external traces of the calcareous covering appear by the formation of three to five protuberances round the mouth, which becomes then distinctly traceable, while the opposite end is somewhat pyramidal. The anterior prolongations multiply somewhat differently in various genera, and increase in length. When after about a month this stage had been attained, both the pyramidal posterior and the anterior prolongations become gradually absorbed, while all the internal organs are well indicated; at the end of the posterior prolongation appears the rudiment of the madreporiform plate, towards which the aquiferous system concentrates. After some time the larval pyramidal form with the calcareous cylinders gradually disappears, when pedicells and pedicellariæ have become developed on the surface of a small excentric protuberance which appears at the side of the mouth; some cylindrical spines also become apparent, the last remains of the larva vanish, internally the calcareous plates are formed, and the young Echinoid gradually assumes the form and shape of the old.

The Echinoids effect their locomotion and attachment to foreign bodies through the different kinds of pedicells, and also the spines, the latter serving besides as organs of defence. All are marine inhabitants, mostly in moderate depths. Some live on sandy or gravelly ground, others on coral reefs, hiding in crevices, or even excavating holes in solid rocks with the abrading power of their spines. Though also found in northern and temperate seas, they are of course most numerous and most varied in tropical climates. In former periods they also appear to have been generally distributed, but their number was smaller.

For reasons which have already often been alluded to, the study of the Echinoids is of very great importance. In tracing the successive forms as they followed each other in course of time, there is an unmistakeable gradual change observable from the spheroid to the hemispheroid and bilateral types. Many of the genera and species are most characteristic for certain formations and even for single beds, setting aside the certainty with which identifications of species can often be carried out. With the termination of each epoch, but particularly the cretaceous, many very important intermediate links have disappeared, and the study of these fossil forms is, particularly in this class, absolutely indispensable for purposes of a correct and natural classification. Hence the importance of the Echinoids for the geologist as well as for the zoologist.

The knowledge of the fossil species has, especially within the last few years, been very considerably enlarged through the labours of Desor, Cotteau, Laube, and a few others; but that of the recent forms has scarcely made equal progress, though some important observations were made by E. v. Martens, Sars, and others. It is only to be regretted that our anatomical and morphological knowledge of the entire order is as yet very small.

A short abstract of the principal sub-orders and families may be found useful, more details will be added further on. The two principal divisions of the order are, as already noticed, 1, the palæozoic Tesselati, or Palæo-echinoidea,—with, 35—75 radial zones of plates, mostly spheroidal in shape, with the oral and anal openings central, the former on the lower, the latter on the upper side,—and 2, the Eu-echinoidea with only twenty radial zones of plates. This latter sub-order is divisible in the following manner:—

EU-ECHINOIDEA.

A. *Endocyclica*, round or angular, spheroidal; mouth inferior, central, anus within the apical disc.

(*a*) Apical disc, composed of ten plates surrounding the anal opening which is central; jaws present.

1. *CIDARIDÆ*, ambulacra mostly somewhat flexuous, narrow, with very small equal tubercles, or finely granulated; inter-ambulacra with large tubercles; peristome entire, circular or pentagonal.

2. *DIADEMATIDÆ*, ambulacra slightly flexuous or straight, wide, provided with larger tubercles, as are also the inter-ambulacra; peristome with incisions, decagonal.

3. *ECHINIDÆ*, ambulacral and inter-ambulacral plates with numerous small tubercles, poriferous zones with more than two pores in a transverse series, often crowded; peristome with incisions.

(*b*) Apical disc composed of more than ten plates; anus central or slightly excentric.

4. *SALENIDÆ*, inter-ambulacra wide, with large tubercles.

B. *Exocyclica*, test round or polygonal, spheroidal or mostly hemispheroidal; mouth inferior; anus always separate from the apex.

5. *ECHINOCONIDÆ*; poriferous zones complete, extending straight from the mouth and meeting above at the central apex in a point; peristome notched; jaws present.

6. *Echinoneidæ*, poriferous zones complete, meeting at the apex; peristome simple, angular; no jaws? (including the *Caratominæ* as sub-family.)

7. *Dysasteridæ*, poriferous zones complete, meeting above in two separate points, (anteriorly as trivium, posteriorly as bivium); jaws absent.

8. *Clypeastridæ*, poriferous zones petaloid, five genital plates, jaws present.

9. *Cassidulidæ*, poriferous zones sub-petaloid, all superficial, ambulacra not depressed, generally four genital plates; mouth central or excentric, round or pentagonal; peristome often with tubercles round it.

- 9*a*. *Cassidulinæ*, with anal opening situated superiorly terminal, in a groove; pores in all zones similar.
- 9*b*. *Echinolampinæ*, with the anal opening inferiorly marginal, not in a groove; pores in all zones similar.
- 9*c*. *Claviasterinæ*, anus inferior, sub-marginal, pores in the anterior ambulacrum somewhat different from others.

10. *Spatangidæ*, some of the ambulacra with the sub-petaloid poriferous zones excavated, mouth excentric, transversely oval, bilabial.

- 10*a*. *Ananchitinæ*, only the anterior ambulacrum generally depressed; apical disc elongate.
- 10*b*. *Spatanginæ*, all ambulacra lie in depressions; apical disc concentrated.

Out of these ten families, seven are represented in the South Indian cretaceous deposits, but mostly only a few species occur in each.

Following the groups as above arranged, there is a gradual change observable from the purely actinoid or radial to the bilateral type, which is most developed in the *Spatangidæ*, and according to the arrangement previously adopted in the present series of monographs of South Indian cretaceous Invertebrata, I shall begin the detailed account with the last-named family. The distribution of the species in the different geological groups, as presently distinguished, will be noticed subsequently in a few general remarks on the subject.

In conclusion, I may just allude to a short paper on the classification of the Echinoidea by M. Pomel, published in the *Comptes Rendus* for August 1868, p. 302. This paper is an abstract from the author's introduction to the Tertiary Echinoidea of Algiers. M. Pomel proposes to divide the order into three divisions, *Spatiformes*, *Lampadiformes* and *Globiformes*. The first are typified by the *Spatangidæ*, the second by the *Cassidulidæ*, and the third by the *Cidaridæ*. Although the author is strongly of opinion that these divisions are considerable improvements upon the classification now more generally in use, it appears to me that his views are based upon the examination of only a limited number of forms from rather recent deposits, without much regard to the older representants of the order.

Family,—SPATANGIDÆ.

Desor, Synop. Echin. foss., p. 327.

The members of this family usually have a cordately ovate, more or less elevated test, with the anterior ambulacrum differently developed from the rest, and generally situated in a groove; the others are more or less distinctly petaloid; the mouth is transversely sub-ovate or kidney-shaped, situated before the lower middle, with raised lips; no jaws are present; anus at the posterior, truncate end; a post-oral space is always marked on the lower side between the two posterior ambulacra, which are produced from the apex to the mouth; apical apparatus composed of four perforated genital plates, the right anterior of which is, as usually, the madreporiform.

Two sub-families are usually distinguished, the *ANANCHITINÆ* and the *SPATANGINÆ*. In the first group, which is by some authors also separated as a special family under the name *ECHINOCORIDÆ*, the ambulacra are perfectly open towards the periphery of the test, with the exception of the impair one, the other four lie flat on the surface, and the apical apparatus (except in *Stenonia)* is elongated, the anterior genital plates being sometimes quite separate by intervening ocular plates from the posterior pair. Two genera are represented of this sub-family in the South Indian cretaceous rocks—*Holaster* with one, and *Cardiaster* with two species.

The *SPATANGINÆ* have the petals situated in more or less marked depressions; the anterior one is continued to the mouth, the others are sub-petaloid, sometimes nearly closed on the upper side, or the pores become, when continued further on, much less distinct and much smaller at the periphery. The apical disc is short, the four genital plates being in immediate contact; the majority of the genera have fascioles. Of this sub-family again two genera occur in South India—*Epiaster* with one, and *Hemiaster* with eleven species.

Lütken, in his *Bidrag til Kundskab on Echinoderme* in 1864, gives a slightly revised classification of the *SPATANGIDÆ*, according to the presence or absence or form of the fasciolæ, but the few alterations proposed do not appear to me to be of any essential importance.

Of the fifteen species of South Indian cretaceous *SPATANGIDÆ*, I have, strangely enough, not been able to identify a single one with a known European or American form, but there are a few exhibiting noteworthy relations which will be noticed in due course. Representatives of the family are scarcely known from older beds than cretaceous, and to this formation also by far the greatest number of species is peculiar. The *ANANCHYTINI* (about 50 species) are with very few exceptions all cretaceous; of the *SPATANGINI* (about 300 species) nearly more than one-third are cretaceous, nearly an equal number is tertiary, and the remainder recent.

A peculiarity of the *SPATANGINÆ* consists in the occasional presence of certain narrow zones on the test, on which the tubercles generally distributed over the surface are absent or merely represented by fine granules; these zones have been named fasciolæ, of which five kinds are distinguished: 1, *fasc. peripetala*, surrounding the terminations of the petals; 2, *fasc. interna*, including the apex and the anterior petals only; 3, *fasc. marginalis*, surrounding the test at or near the periphery of the half height; 4, *fasc. lateralis*, running from the former posteriorly, and 5, *fasc. analis*, surrounding the anal opening. Several genera are distinguished according to the presence or absence of these fascioles.

I. *Genus.*—HEMIASTER, *Desor*, 1847.

The Spatangoids, included in this genus, are mostly of small size, angularly or roundly ovate, and of moderate height; the petals or ambulacra are depressed, generally unequal, the anterior always traceable, though not equally developed as the other four; they are surrounded by a peripetal fasciole; the mouth is transversely kidney-shaped, with slightly thickened entire lips; the anus posterior near the upper end, and vertically roundly ovate; the genital apparatus is solid and composed of four plates with comparatively large round openings; surface more or less distinctly tuberculated and granular; the tubercles on the upper or inter-ambulacral areas are often slightly larger, or at least more distant, than those near the periphery.

Hemiaster is one of the most widely distributed genera, being represented by numerous species both in cretaceous and tertiary deposits, though more common in the former. Eleven species of the *genus* occur in the South Indian cretaceous rocks; one was described by D'Orbigny, and three as *Brissus* by Forbes. Those of the latter author were first referred by D'Orbigny to *Hemiaster*, and then by Desor to *Periaster*, but D'Orbigny's generic determination appears to be the correct one—at least, as far as I have been able to satisfy myself by the examination of authenticated specimens.

1. HEMIASTER SIMILARIS, *Stoliczka*. Pl. I, Fig. 1.

H. testa depresse ovata, postice angustatim subtruncata, supra paulo convexiuscula, undique moderate tuberculata; apice centrali; ambulacris lateralibus profunde impressis, sublævigatis, truncatis, inæqualibus, antero-lateralibus multo majoribus, antico longissimo sed cæteris minus profundo, granulose tuberculato, depressione prope peripheriam fere obsoleta.

Test depressed, slightly convex above, almost regularly ovate, with rounded periphery, subtruncate posteriorly, and the anal end somewhat higher than the oral. The anterior ambulacrum is the longest of all, moderately deep, of equal width throughout, shallowing out almost entirely towards the margin; the plates in it are covered with small tubercles and numerous granules; there are 28 pairs of pores in each row, the last more distant than the others, and the pores in each pair are separated by a very distinct small granule; the remaining ambulacral plates beyond the fasciole are much elongated, and each has in the outer anterior angle a pair of very small pores. The lateral ambulacra are very deep, broad, truncate, very finely granulated; each postero-lateral is only three-fifths of the length of an antero-lateral; the latter diverge under an angle of 98 degrees, and have in each series about 40 pairs of pores, while the former diverge under an angle of 62 degrees, and each series consists of only 25 pairs of pores. The fasciole is of a similar shape as the test, slightly contracted at the posterior sides.

On the lower side the surface of the test is not preserved in the single specimen. The aperture lies rather close to the anterior end, the distance of the upper lip from it being two-elevenths of the total length. The anus is large, rather near the upper edge of the posterior flattened end.

Locality.—Ootatoor, in a brown compact limestone; apparently very rare.

Formation.—Ootatoor group.

The only known species to which the present form bears a close resemblance is from the Cenomanian beds of the Department Yonne, and is figured[*] by Cotteau as *Hemiaster Perroni*, Etallon; it differs from the Indian fossil by a more posteriorly situated apex, greater height and stronger convexity of the upper surface.

2. HEMIASTER EXPANSUS, *(Forbes).* Pl. I, Fig. 2.

1846. *Brissus expansus*, Forbes, Trans. Geol. Soc., Lond., VII, p. 160, pl. 19, fig. 7.
1855. *Hemiaster id.*, apud d'Orbigny, Pal. Franç. terr. cret., vol. VI, p. 266.
1858. *Periaster id.*, apud Desor, Synops. Echin. foss., p. 388.

There is unfortunately no specimen of this remarkable species in our collection, but when examining in 1867 Prof. Forbes' original, I found the specimens to accord with the figure and description given by Forbes, and I can, therefore, do no better than transcribe his notes with slight alterations.

Hem. testa ambitu suborbiculari, supra modice convexiuscula, vertice centrali; ambulacris impressis, truncatis, antero-lateralibus longissimis, antico breviore, poris minutis instructo; spatio post-orali late ovato; superficie undique granulifera, fasciola polygona, dimidio postico multo augustiore.

Length 66 *m.m.*, *width* 67, *greatest height* 33 *m.m.*

"Nearly round, or very broadly cordate, depressed by convex. The dorsal "ambulacra are all petaloid and narrow, the antero-laterals being to the posterior "ones as three to two. The former have about thirty-two pairs of pores, connected "by grooves, in each series; the latter about twenty-three. The ambulacral im-"pressions are flat centrally, and the lowermost pore of each pair is advanced a "little towards the centre of the plane. The junction of the ambulacral plates in "the centre of the depression is rather narrow and has very steep parallel sides. "The anal end is very obtuse, and the truncation slopes rapidly towards the under "surface."

The pores in the anterior ambulacrum are very small, close together in each pair, and about 16 in number in each series; this ambulacrum is shorter than one of the antero-laterals. The latter diverge under an angle of 105, and the postero-laterals under an angle of 78 degrees. The entire surface is granular, the granules being somewhat stronger below than above. "The post-oral space is broadly ovate and rather convex, but the cheeks are nearly flat."

No locality is given, but the specimens appear to be either from the calcareous sandstone at Pondicherry, or from near Ootatoor, belonging to the Ootatoor group.

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[*] Etudes sur les Echinides fossiles du Dept de l'Yonne, pl. 70, figs. 1—4.

3. HEMIASTER TUBEROSUS, *Stoliczka*. Pl. I, Figs. 3—6.

H. testa ambitu undulate cordiformi, postice anguste truncata, modice alta, supra convexiuscula, antice convexe declivi, postice paulo altiore, inferne fere plana, confertim tuberculata, tuberculis in regione supera, fasciola peripetali distincta minutissimeque granulata circumdatis, multo majoribus atque distantioribus quam ad peripheriam, sed iis in regione antero laterali infera sitis fere æqualibus; regione post-orali elongate triangulari, ambulacris minute granulosis marginata, tuberculis prope aperturam majoribus, posticeque minoribus, densis ornata; tabulis omnibus testæ convexiusculis; ambulacris valde inæqualibus, postero lateralibus dimidio antero-lateralium æquantibus, sulco anteriore ceteris minus profundo; fasciola magna, antice usque ad peripheriam extensa, dimidio postico rapide contracta.

This is a very well marked species, readily distinguished by the much greater size of the tubercles on the upper surface within the peripetal fasciole, than at the periphery; on the anterior portion of the lower surface they are largest; on the triangular, somewhat elevated, post-oral space anteriorly large, posteriorly smaller and very closely arranged. The test is moderately elevated, cordate, with a slightly undulating outline, all the ambulacral and inter-ambulacral plates being slightly convex; posterior half slightly higher and narrowly truncate at the end. All the ambulacral plates are perforated, the posterior on the lower side much elongated and only finely granular.

The anterior sulcus is of almost equal width throughout, but shallower than the other ambulacra, the postero-laterals are half the length of the antero-laterals, and both are truncate at the end; the latter diverge under an angle of 100 degrees, and each is composed of about 36 pairs of pores; the postero-laterals under an angle of 70 degrees, and there are about 20 pores in each series. Each pair of pores is separated from the next by a fine granulated ridge, lining a slightly broader furrow; the pores are rather close together, but become more widely separated towards the ends of the petals.

The posterior half of the fasciole is rapidly contracted; anteriorly it reaches very nearly to the periphery of the test.

Localities.—Karapaudy and South-East of Mulloor, in coarse sandstone, very common; Olapaudy, in a ferruginous oolitic rock, less common; a single specimen is from a grey fine-grained sandstone, North of Alundanapooram. This last locality lies within the geographical limit of the Trichinopoly group, but the preservation of the specimen is exactly the same as those from the Arrialoor beds.

Formation.—Arrialoor, and (?) Trichinopoly group.

4. HEMIASTER FRONT-ACUTUS, *Stoliczka*. Pl. I, Figs. 7-8.

H. testa rotundate sub-ovata, sub-angulata, antice sulcata, postice concaviuscula, sub-truncata, supra infraque sub-æqualiter convexiuscula, ambitu anteriori paulo depresso, sub-carinato; ambulacris profundis, antero-lateralibus multo longioribus, sub-flexuosis, ad terminationem fere clausis; superficie supra minute, ad peripheriam infraque distinctius, granulata.

A moderately depressed, angularly and rather roundly sub-ovate species, with the lower portion of the anterior periphery peculiarly angular, or almost sub-carinate, the cheeks being flattened; the upper side is slightly more convex than the lower, and the posterior end narrowly truncated. All the ambulacra are deeply impressed, the anterior a little less than the others, but the furrow passes over the periphery on to the lower side; its pores are small, composed of about twelve distant pairs from the centre to the fasciole; the lateral ambulacra are nearly closed, the anterior series of pairs of pores bending conspicuously towards the middle line.

The antero-laterals diverge under an angle of 75 degrees, the postero-laterals under an angle of 52 degrees; the former are somewhat flexuous, each series composed of about 30 pairs of pores, separated by fine granules; one of the latter is barely more than half the length of the former, elongately ovate, and there are about 17 pairs of pores in each series. The two anterior genital pores are very much larger than the posterior. The fasciole is laterally not distinctly traceable, but appears to have been very much contracted. The tubercles are conspicuously larger on the lower than on the upper side.

This description refers to the larger specimen figured; its form is slightly changed by accidental pressure, and the median hinder crest is injured, the consequence being a greater roundness of the periphery than it appears to have naturally possessed.

Another smaller specimen has a comparatively higher and slightly more ovate test; the ambulacra are similarly placed, and relatively of equal proportions, but the pores are less numerous; one antero-lateral has only 20 pairs, and one postero-lateral 11 or 12 pairs in each series. The granulation of the surface and the sharpness of the anterior edge is in both specimens exactly similar.

Locality.—Near Ootatoor, in a yellowish sandy limestone. Only the two figured specimens were examined.

Formation.—Ootatoor group.

5. HEMIASTER VICINUS, *Stoliczka*. Pl. II, Fig. 1.

H. testa ovato cordata, supra modice convexa, infra convexiuscula, in tota superficie fere æqualiter atque crassiuscule tuberculata, apice subcentrali, postice paulo elevatiore quam antice, lateribus convexiusculis, in parte anteriore rotundate subangulatis; ambulacris profundis, sulco anteriori latissimo, ad peripheriam valde *angustato; antero-lateralibus posticis modice longioribus, poris parvis approximatis instructis; regionibus buccalibus convexiusculis.*

Test ovately cordiform, with rounded anterior lobes and somewhat angular at the sides; upper surface moderately convex, sides roundly sloping, cheeks and post-oral region slightly convex, the latter is bounded on either side by shallow furrows; entire surface covered with comparatively large tubercles. The ambulacra are all deeply impressed, the anterior widest, but becoming considerably narrower and shallower at the periphery and on the lower side. One of the postero-laterals has about 26 pairs of pores in a series, and is fully two-thirds as long as one antero-lateral, which has about 38 pairs; both pores in each pair are small, connected by a fine groove; the pairs lie very close together, except the few last ones which become slightly more distant and approach each other towards the middle line; the antero-laterals form an angle of 95 degrees, the postero-laterals of 52 degrees. The aperture is one-fourth of the length of the test distant from the anterior end. The peripetal fasciole is not distinctly traceable.

The greater length of the postero-lateral ambulacra, and the rounded anterior periphery readily separate the present species from the previous, and the great number of small closely set pores in the ambulacra differ from those of any other known species of equal size.

Locality.—South of Moraviatoor, in brownish nodular limestone. Besides the figured specimen, there is one very small (11 m.m. long) specimen from the same locality; it is considerably more depressed, but does not differ in other respects.

Formation.—Ootatoor group.

6. HEMIASTER INÆQUALIS *(Forbes)*. Pl. II, Figs. 2—3.

1846. *Brissus inæqualis*, Forbes, Trans. Geol. Soc., Lond., vii, p. 160, pl. xix, fig. 6.
1855. *Hemiaster id.*, apud D'Orbigny, Pal. Franç. terr. cret. vi, p. 267.
1858. *Periaster id.*, apud Desor, Synop. Ech. foss., p. 388.

H. testa depresse hemispherica, ambitu orbiculari-cordato, ad peripheriam subangulata, infra planata, lateribus fere uniforme convexe declivibus, postice anguste truncata, supra dense granulata, sæpissime sub-lævigata, fasciola indistincta instructa, infra distinctius tuberculifera, regione ante-orali lateraliter plana aut fere concaviuscula, post-orali convexiuscula, elongate elliptica; vertice subcentrali; ambulacris valde inæqualibus, sulco antico supra modice concavo, ad peripheriam profundissimo, sed vix latiore, ambulacris antero-lateralibus posticis multo longioribus, omninis terminationibus truncatis; apertura prope marginem anteriorem sita.

Test roundly cordate and almost regularly convex, sloping towards the sides, posteriorly narrowly truncate and below generally flattened; the ante-oral space being quite flat or almost concave, and the post-oral elongately ovate and moderately convex; the aperture lies very close to the anterior margin, its distance from the anterior ambulacral furrow being one-seventh of the length from the same point to the anal end; the apex is central. The upper surface is rather finely granular, but as the granules very easily wear off, it generally appears to be almost smooth; on the lower surface the granules are, however, much more distinct.

The ambulacra are very unequal. The anterior ambulacral furrow is slightly less deep than the others, it is of almost equal breadth throughout and deepest at the periphery; from the centre to the fasciole are 16 plates with small rather indistinct pores. One of the antero-lateral ambulacra has about 30 pairs of pores in one series, and is very nearly or fully double the length of one of the postero-laterals, each of which has about 17 pores; the former diverge under an angle of 112 degrees, the latter under 62°. The pores in each pair are connected by a groove, sometimes divided longitudinally by a raised line, while the low ridges between each following pair of pores are granular.

Forbes in his original description gives the number of pores in the antero- and postero-lateral ambulacra as less numerous; they were probably taken from a smaller specimen than the one figured by him, for in that one the number corresponds with that given above; the proportions in the number of pores are in both cases very nearly equal.

The same author further states that the 'frontal furrow gradually widens;' this is due to an abrasion of the lateral edges near to the periphery; the furrow is of almost equal width throughout in well preserved specimens, but it always gradually deepens towards the periphery.

Locality.—Ootatoor, in a rather sandy, grey limestone.

Formation.—Ootatoor group.

7. HEMIASTER RANA *(Forbes)*. Pl. II, Figs. 4—5.

1876. *Brissus rana*, Forbes, Trans. Geol. Soc., Lond., vii, p. 161.
1855. *Hemiaster id.*, apud D'Orbigny, Pal. Franç. terr. cret., vi, p. 263.
1858. *Periaster id.*, apud Desor, Synop. Echinid. foss., p. 388.

" *Hem. ambitu sub-orbiculari, sub-angulato, dorso elevato, vertice sub-centrali* " *(postico*); ambulacris profunde impressis, antero-lateralibus longioribus lanceo-* " *latis, posticis ovatis: sulco antico profundo, lato, lateribus sub-declivibus, inferne* " *spatio postorali late ovato.*

Length, $1\frac{1}{2}$ *inch. Breadth,* $1\frac{6}{15}$ *inch. Greatest height,* $1\frac{2}{10}$ *inch.*

"A very tumid sub-globose species, slightly broader than long, and rather " angular in outline. The sides slope steeply. The anal extremity is suddenly and " perpendicularly truncate. The anterior and central furrow is rather wide, and has " sides which appear to slope, owing to the rounding of the angles. This furrow is " not so deep as the latero-dorsal ambulacra. The anterior pair are lanceolate, and

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* Figura verticem antero-centralem exhibet.

"the posterior ovate, approximate and very deep. In the former are 23 pairs of "pores in each series, placed on the slopes of the depression; in the latter 18. "Beneath, the surface is convex posteriorly in consequence of the form of the "post-oral space, but the cheeks are nearly flat."

Such is Forbes' description of this species. When examining Forbes' type in 1867, in the collection of the Geological Society of London, I observed, that it is closely allied to *H. inæqualis*, being somewhat more convex, particularly at the sides towards the periphery, and also higher in proportion to the length. I do not remember the exact form of the petals, but the description does not tally with the figure. Forbes calls the antero-laterals "lanceolate" and the posteriors "ovate;'. the figure shews them both truncate, quite as much so as in the next species.

We possess in our collection only a fragment (see fig. 4, pl. ii) which was many years ago presented by Mr. Cunliffe, and which appears to be referable to the present species. The apex is somewhat depressed, with the genital plates well preserved; the madreporiform plate is so large as to entirely separate the posterior right plate from its corresponding left one. The upper surface of the test is finely granular, the lower more coarsely, while at the sides the granules are nearly obsolete. The anterior pair of ambulacra diverge under an angle of nearly 130 degrees, the posterior under an angle of about 60°; one series of the former has 25 pairs of pores, one of the latter about 20; in each case the smallest pores near the apex are included. The pairs are rather distant, and the pores in each connected by a groove; towards the end they slightly approach each other, and hence probably Forbes' terms of 'lanceolate' and 'ovate.'

The postero-lateral ambulacra are one-third shorter but somewhat deeper than the antero-laterals. The form of the fasciole is as figured by Forbes, its posterior half becoming very abruptly contracted immediately after passing round the antero-lateral ambulacra.

Locality and Formation.—The above-noticed fragment is from the soft whitish sandstone near Pondicherry, belonging to the Arrialoor group, and it is most probable that the specimen described by Forbes is from the same locality.

8. HEMIASTER INDICUS, *Stoliczka*. Pl. II, Figs. 6—7, & Pl. III, Fig. 1.

H. testa ovato cordata, apice subcentrali, vel postico, lateribus convexis postice paulo altiore quam antice, medio rotundate cristata, ad terminationem verticaliter truncata, infra convexiuscula; undique granulato-tuberculifera, tuberculis intra fasciolam peripetalem distantibus, ad peripheriam approximatis, infrá paulo majoribus. Ambulacris excavatis: sulco anteriori lato, lateribus subrotundatis, ad peripheriam subangustato, ab apice usque ad fasciolam in una serie poris 22 instructo, primis approximatis, ultimis valde distantibus; ambulacris lateralibus subæqualibus, *truncatis, anticis longioribus atque valde divergentibus, posticis brevioribus, approximatis, ambobus ad terminationes truncatis.*

This is a species evidently closely allied to *H. rana*, but differing from it by the much larger and more regularly ovate shape of the fasciole, well developed tubercles, besides the granules on the surface, and by a greater length of the lateral ambulacra, provided with more numerous pores. One antero-lateral is only about one-sixth longer than a postero-lateral, the former having about 35 and the latter about 30 series of pores in one series. The pores are connected by distinct grooves, and each pair is separated from the next by a fine granular ridge; the last pairs in each series are somewhat more distant than the preceding. The antero-laterals diverge under an angle of about 115° to 122,° the postero-laterals at the base under an angle of about 55°, but as they proceed backwards the angle decreases to only about 40 degrees.

The tubercles within the fasciole are about equal in size to, but distinctly more distant from each other, than those near the periphery, while those at the lower side are conspicuously larger. The cheeks are rounded; the aperture about one-fifth of the length of the test distant from the anterior end; the lower lip is very prominent and granular; the post-oral space much contracted near the aperture, coarsely tubercular. The position of the apex slightly varies; it is generally subcentral, sometimes slightly posterior. The anal end is broadly truncate, and the anus is very near the upper end, as in *H. rana*.

Localities.—South-West of Mulloor, South-East of Arrialoor, and East of Serdamungalum, in reddish ferruginous or whitish sandstone.

Formation.—Arrialoor group.

9. HEMIASTER CRISTATUS, *Stoliczka*. Pl. III, Figs. 2—5.

H. testa ambitu angulate cordato, postice aliquanto elongata, medio acute angulata seu cristata atque paulo declivi, ad terminationem fere verticaliter sed anguste truncata; infrá regione post-orali deplanata, ante-orali lateraliter convexiuscula; apertura semilunari, immersa; superficie distincte granulata et tuberculifera, tuberculis in latere inferiore maximis, intra fasciolam minoribus et distantioribus; apice antero-centrali, ambulacris profundissimis, fasciolá ambitu testæ similari circumdatis; sulco anteriore latissimo, rapide declivi; ambulacris antero-lateralibus posticis longioribus, ad terminationes truncatis; primis angulo 130°—140° *divergentibus atque in una serie* 38—40 *paria pororum exhibentibus, alteris angulo circa* 40° *junctis atque* 28—30 *poros in una serie gerentibus.*

A species very closely allied to the last, but the apex is more anterior, the ambulacra much deeper, the posterior inter-ambulacral space carinated, the fasciole is distinctly smaller, the posterior termination is lower, more narrowly

Locality.—The species was obtained at Pondicherry, in beds which according to their fauna are classed with the Senonien or the white chalk. Judging from the similarity of the species to the three preceding ones, I have little doubt that these beds belong to the Arrialoor group, and, therefore, D'Orbigny's determination of the group is perfectly correct.

II. *Genus.*—EPIASTER, *D'Orb.*, 1853.

Pal. Franç. terr. cret., tom. VI, p. 186.

This genus includes a number of species of the usual spatangoid cordate shape, with the ambulacra slightly impressed, the anterior sulcus being shallow, the pores in the zones equal; the surface granulated, with intermixed sub-equal small tubercles; four genital plates in contact; fasciole absent. The last negative character is the only one which separates the genus from *Micraster*, possessing a sub-anal fasciole. Cotteau (Synops, Echinid. foss., p. 360) considers this difference as not sufficient to constitute a distinct genus, and unites, therefore, both under *Micraster*. However, so long as the character of the presence of a fasciole is constant, it should, I think, deserve value similar to that which is attributed to the presence of a peripetal fasciole in *Hemiaster*, and its very close ally, *Periaster*, which latter has in addition also a lateral fasciole. The distinction of all these genera is entirely based upon the presence or absence of a certain kind of fasciole.

The species of *Epiaster*, as likewise those of *Micraster*, are cretaceous, with the exception of Laube's *Micraster brevistella*, which occurs in tertiary beds at the Murray Cliffs in South Australia; as no mention is made of the presence of a sub-anal fasciole, the species is probably referable to *Epiaster* (compare Sitzb. Akad. Wien, Math. Nat. Klasse, 1869, vol. 59, pt. I, p. 192, fig. 7).

1. EPIASTER NOBILIS, *Stoliczka*. Pl. III, Figs. 7—8.

Epiast. testa depresse cordata, ad peripheriam sub-rotundata, ambitu paulo undulato, postice anguste truncata; ambulacris paulo impressis, sub-flexuosis, sub-æqualibus, antero-lateralibus valde–, posticis modice– divergentibus, apice sub-centrali (antico); poris genitalibus magnis; superficie supera minutissime granulata, atque minute tuberculata, infera tuberculifera, regione post-orali prope labium perangusta, deplanata, postice paullulum elevata; apertura rodundate ovata; ano sub-rotundato, ad marginem superiorem regionis interambulacralis convexiusculæ sito.

This is one of the most beautiful and most perfect species of Spatangoids found in the South Indian cretaceous deposits. It has a depressly cordate shape with the anterior sulcus very slightly marked; the margin is rounded and the entire periphery slightly undulating; the apex is somewhat anterior to the centre, the post-apical region very little elevated, and gradually curved to the anal end, which is rather low, narrowly truncate, and sloping inwardly below the rounded anus. The cheeks are convex; the aperture is roundly oval; the post-oral space sub-triangular, flat anteriorly and very narrow at the lip, slightly elevated towards the anal end. The upper surface is covered with very minute granules and fine tubercles, and the lower is coarsely tubercular between the granules, except towards the hinder end of the post-oral area.

The ambulacra are slightly impressed and somewhat flexuous; the antero-laterals diverge under an angle of 122 degrees, the postero-laterals under an angle of about 53 degrees, but at the base they actually diverge under a much larger angle; the former have 36 pairs of pores in each series, the latter about 30 in the anterior and 26 in the posterior zone; the pairs are separated by granules; in all cases the pores continue to remain traceable on the ambulacra, although further on they become less distinct and more distant. The genital plates have very large openings, the anterior left is the smallest, the madreporiform one the largest, the two lower ones are wider apart and narrowly in contact.

Localities.—South-West of Mulloor in a ferruginous sandstone, East of Olapaudy in a sandy oolitic rock; very common at both localities; rarer in the neighbourhood of Karapaudy and East of Serdamungalum.

Formation.—Arrialoor group; apparently a very characteristic fossil of this division of the cretaceous beds.

III. *Genus.*—CARDIASTER, *Forbes*, 1850.

Test cordiform, moderately convex; ambulacra unequal; anterior sulcus distinct, margined by more or less strongly angulated edges; lateral ambulacra open, the pores composing the posterior pairs in each series often larger than the anterior; apical apparatus ovate, elongate, composed of four genital and five ocular plates, the two anterior genital plates in advance of the junction of the antero-lateral ambulacra; surface more finely tuberculated and granular above than below, but generally with some enlarged tubercles along the edges of the anterior sulcus and about the apex; aperture transversely kidney-shaped; anus posterior, vertically ovate; a lateral fasciole passing all round near the lower periphery is said to be characteristic, but it is not always distinctly marked.

This genus was proposed by Prof. E. Forbes for the well-known *C. ananchytis*, (Leske), (= *C. granulosus*, Goldf.), and is easily distinguished by the above-noticed characters from both *Holaster* and *Hemipneustes;* the latter shows a similar inequality in the size of the ambulacral pores, but it has the granulation of the surface equal, and does not possess a lateral fasciole.

All the species of *Cardiaster* as yet known are from cretaceous beds; two occur in the uppermost beds of South Indian cretaceous deposits, and both are new to science.

1. HOLASTER INDICUS, *Forbes*. Pl. IV, Fig. 5.

'*H. cordatus, inflatus, postice altior, extremitate anali obtuse rostrata, infra 'spatio postorali convexa, subcarinata.*

'Length $1\frac{6}{10}$ inch. Breadth $1\frac{1}{2}$ inch. Greatest height 1 inch.

'Very regularly heart-shaped, nearly as broad as long. Back most convex 'posteriorly in the space between the two postero-lateral ambulacra. Behind, the 'highest part of the body contracts a little as if pinched in, and is narrowly truncated at the anal extremity. The anterior extremity is deeply cordate. The series 'of pores forming the ambulacra gently diverge, and almost all nearly equally. In 'each series of the four dorsal ambulacra there are about twenty-four pairs of open 'pores, the last five being placed distant from each other. The pairs of the several 'series are not connected by grooves. The anal area is vertically oblong. On the 'under surface the most prominent part is the post-oral space, which is oblong, very 'convex, and has a tendency to carination. The antero-lateral portions (cheeks) 'are rather tumid.

'The nearest allies of this species are the *Holaster suborbicularis* from the 'upper chalk of Maastricht and equivalent formations. That species, however, has 'the apex of the back in the region of the ocelli. The Indian species has a nar'rower anterior groove. It is also allied to the *Holaster l'Hardyi* of the Neuchatel 'greensand, but differs in the disposition of the ambulacra.'

Family,—CASSIDULIDÆ.

See Desor, Synops. Echinid. foss., p. 245.

The *CASSIDULIDÆ*, as arranged by Desor, include Echinoids of moderate or rather large size, variable in shape, round or polygonal, convex above, flat or slightly concave below, covered with small, mostly imperforated, tubercles, surrounded with rather deep areolæ, small above and usually larger below; the apex and mouth are very variable in position, very often sub-central or excentric, the former composed of four genital and five ocular plates, the latter angular or pentagonal, surrounded with lobes or not; ambulacra petaloid or sub-petaloid, sometimes nearly continuous, but not situated in depressions, the petala being open, though always somewhat contracted towards their ends, they are all of equal or very similar shape; the poriferous zones* often re-appear better marked near the peristome of the mouths; no jaws are present; the position of the anus varies between supra-marginal, posteriorly terminal, or infra-marginal; the spines are mostly thin and small, longitudinally striated.

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* The name buccal rosette or floscelle has been proposed by Desor for the oral ambulacra in connection with the oral lobes.

Desor proposed to separate the family into three sub-divisions, which appear to require some alterations. The CARATOMINI should, I think, be entirely excluded and form a special section of ECHINONEIDÆ, or a separate family. The remaining genera might be classed in three sub-families.

1. CASSIDULINÆ, with the anal opening situated in an upper or terminal, more or less distinctly pronounced depression, generally of a somewhat larger size than the anus itself. The characteristic genera are *Cassidulus*, *Echinobrissus*, *Catopygus*.

2. ECHINOLAMPINÆ, with the anus situated inferiorly, more or less close to the posterior end, and with the margins simple, sometimes slightly sloping, but without any special depression. *Echinolampas*, *Conoclypeus*.

3. CLAVIASTRINÆ, with the apex of the test somewhat elevated, the pores in the anterior impair ambulacrum somewhat different from those of the rest, generally smaller, and with the anus situated inferiorly sub-marginal.

The first and second sub-families are considered by Dr. Wright to form distinct families, under the names ECHINOBRISSIDÆ and ECHINOLAMPIDÆ, but judging from the variable position of the anal opening in other families, as, for instance, in the ECHINOCONIDÆ and ECHINONEIDÆ, I scarcely think that the character should receive primary importance in point of classification.

The CASSIDULIDÆ are known from the jurassic period up to the present time, but the number of recent species is not very great; the maximum of development falls in the cretaceous period.

In the South Indian deposits the first sub-family, or the CASSIDULINÆ, is the only one represented, namely, by five different genera: *Catopygus*, *Botriopygus*, *Stigmatopygus*, *Nucleolites*, each with one, and *Cassidulus* with five species.

V. *Genus.*—CATOPYGUS, *Agassiz*, 1834.

Test of medium size, generally sub-cylindrically ovate, moderately elevated, posteriorly nearly vertically truncated, often with a slight projection above the anus, which is situated at the upper end of the truncation; below flattened, surface very finely tuberculated; mouth and apex generally excentric, the former pentagonal, or nearly so, surrounded by five lobes, the latter composed of four perforated genital and five very small ocular plates; ambulacra sub-petaloid, pores distinctly yoked.

The peculiar more or less cylindrical shape of the test easily separates this genus from all other CASSIDULIDÆ, except *Oolopygus*, which merely differs by having the pores of the ambulacra not yoked.

Until very recently all the *Catopygi* known were from cretaceous deposits, of which formation the genus was considered to be particularly characteristic. The exception refers to a species, *C. elegans*, described by Laube from tertiary deposits of the Murray Cliffs in Australia, (comp. Sitzb. Akad. Wien, Math. Nat. Klasse, vol. lix, pt. i, 1869, p. 190).

CATOPYGUS SULCATELLUS, *Stoliczka*. Pl. IV, Figs. 6—7.

C. testa subcylindrica, modice elevata, supra convexiuscula, parte posteriore paulo latiore atque altiore, ad terminationem truncata, supra anum paululum producta, infra concaviuscule planata; superficie undique dense crassiusque granulifera; apice valde eccentrico, antico; ambulacris inæqualibus, latiusculis ad terminationes externas modice contractis, antico paulo longiore quam duobus antero-lateralibus, duobus posticis longissimis, angulo 40° divergentibus; zonis poriferis aliquanto depressis, sed ambulacro nullo ad marginem peripheriæ extenso; facie inferiore planata, circa aperturam paululum concaviuscula; apertura sub-centrali, late pentagona, lobis parvis tuberculiformibus circumdata.

This is one of the smallest species of *Catopygus* known; it differs from all others by the very eccentric position of the apex, the marked depressions of the poriferous zones of the ambulacra, and the comparatively strong granulation of the surface. The lower side is flattened, sloping towards the periphery, and round the aperture it is slightly depressed. The aperture is slightly less eccentric than the apex, surrounded by five small tuberculi-form lobes, and although its exact shape is not very well traceable in either of the two specimens examined, it appears rather to extend in breadth than in length, the latter case being the usual one in other species of *Catopygus*.

Locality.—Yermanoor, in whitish soft sandstone; apparently rare.

Formation.—Arrialoor group.

VI. *Genus*.—BOTRIOPYGUS, *D'Orbigny*, 1855.

The species of this genus are distinguished from allied *CASSIDULIDÆ* by a usually moderately depressed ovate form, being rather narrow in front and gradually broader towards the posterior, generally rounded, end; the apex is eccentric, anterior, the two posterior ambulacra often somewhat longer than the anterior, and all extend nearly to the peripherical edge of the test; the pores in each pair are unequal and yoked; the anus lies at the posterior end, and is vertically ovate; mouth eccentric, pentagonal, surrounded by more or less distinct lobes, alternating with the elongate oral ambulacra.

With one or two exceptions, all the species as yet known are from cretaceous deposits.

BOTRIOPYGUS *sp. indet.* Pl. IV, Fig. 6.

I mention under this name a very imperfectly preserved specimen of a *Cassidulid* which appears to belong to the present genus. The test is ovate, broader posteriorly than anteriorly, moderately depressed, with a rounded periphery; the apex is anteriorly eccentric, and somewhat raised above the other parts of the test, as in some species of *Faujasia* or *Archiacia*; the two posterior ambulacra are very much longer than the three anterior, which appear to be sub-equal; the pores are yoked, but appear to be nearly equal; the anus is vertically elongated, ovate; it lies at the posterior end, on about the level of the middle height of the test.

The aperture is very much anterior from the centre; it appears to be irregularly pentagonal, slightly broader than long; but, as the superficial part of the shell is entirely removed, it is not seen whether any lobes were present or not. On the upper side the entire surface of the test is also very much worn off, and hence the difficulty in characterising the species, but its form is so well marked that it will be comparatively easy to recognize it, should any better specimen be found in future.

Locality.—In a whitish calcareous sandstone near Arrialoor.

Formation.—Arrialoor group.

VII. *Genus.*—STIGMATOPYGUS, *D'Orbigny*, 1855.

Pal. Franç. terr. cret., vol. vi, p. 331.—Desor, Synop. Echinid. foss., p. 296.

Test of moderate size, ovate in circumference, hemispherical, lower side flat, mouth nearly central, irregularly five-sided, surrounded by five elongated, buccal, tubercles, alternating with smaller ones, which are superseded by very distinct phyllodia; apex subcentral; madreporiform plate large, porose, but not provided with a large pore like the other three genital plates; ambulacra petaloid, of moderate length, the outer row of pores in each zone elongate, groove-like; anus vertically elongately ovate, situated at the upper end of a long bottle-shaped depression; upper surface finely, equally granular, lower with coarse mammillated tubercles, except along the entire median length, this being only finely granular.

As remarked by D'Orbigny, this genus is closely allied to *Cassidulus*, although the above noted characteristic somewhat differs from that recorded by the celebrated French author. The position of the anus is in both genera very much the same, at the upper end of a longitudinal depression in the test, while the principal difference lies in the form of the apical disc and the composition of the petala. In this character the genus agrees with *Echinanthus*, differing from it, however, by the position of the anus.

D'Orbigny, when framing his characteristic of the genus, evidently regarded the Indian fossil as the type of it, but he also referred to the same a European species under the name of *St. galeatus*. Desor (Synop., p. 288) places the species in *Rhynchopygus*, but, strictly speaking, it does not agree much better with that genus than with the present one. It would be useless to speculate on the generic determination of *St. galeatus*, until we know whether the size and form of the anus is strictly correct, and not misrepresented, as it certainly had been in the Indian species; besides this it is necessary to know the character of the granular structure of the lower surface.

The only other species which Desor (l. cit., p. 297) admits in *Stigmatopygus* is *Nucleolites analis*, Sorign., which specific name, although coupled with a different generic one, is quite unnecessarily changed by Desor into *Bervillei*.

1. STIGMATOPYGUS ELATUS, *(Forbes)*. Pl. V, Figs. 1—8.

1846. *Nucleolites (Cassidulus) elatus*, Forb., Trans. Geol. Soc., Lond., vii, p. 162, pl. xix, fig. 1.
1855. *Stigmatopygus elatus*, D'Orb., Pal. Franç. terr. cret., vi, p. 333, pl. 929.
1858. „ „ „ Desor, Syn. Echinid. foss., p. 927.

St. testa ambitu variabili, elongate seu late ovata, atque plus minusve elata, apice aperturaque subcentralibus, oppositis, ano elongato, parvo, ad terminationem angustatam superam depressionis pyriformis sito, marginibus lateralibus depressionis analis transverse irregulariter sulcatis; superficie supera atque regione longitudinali mediana infera minute granulifera, parte reliqua faciei inferioris crasse tuberculifera, tuberculis areola distincta circumdatis; apertura irregulariter pentagona, tuberculis quinque majoribus, atque alteris paulo minoribus interpositis, ambobus elongatis, circumdata; ambulacris petaliformibus, antico longissimo, duobus posticis brevissimis.

Long. speciminis maximi 78 mm., latitudo 60 mm., altitudo 33 mm.

This species is very variable in shape and also in height, the former changing from elongately to rather broadly ovate, while the sides are in younger specimens gradually, in older, or perfectly adult ones, rather abruptly, sloping; the lower surface is flat, slightly depressed round the aperture, which is central, subpentagonal, surrounded by five large, subpiramidal, and five intermediate, smaller, elongately diamond-shaped tubercles, or rather flattened ridges. The oral ambulacra are well developed, each composed of three or four irregularly placed small pores, one series extending along the outer margins of the smaller tubercles, which the ambulacra surmount; the two branches are connected by a few larger scattered pores.

The whole upper and the longitudinal median region of the lower side are finely granular, the rest of the lower surface coarsely tubercular, the large mammillated tubercles more or less extending on the oral prominences, while towards the margins they gradually decrease in size and pass at the edges into granules.

The apex is central or very nearly so, composed of four genital plates, of which the two posterior and the left anterior are largely perforated, while the right anterior or the madreporiform is largest, porose, occupying the whole centre of the apex, but it has not a larger opening. The petala are very unequal, none of them extending even within close proximity of the periphery. The anterior ambulacrum is the longest, the antero-laterals are slightly shorter, and one of the postero-laterals scarcely exceeds three-fifths of the length of the anterior impair one; the antero-laterals diverge under an angle of about 145°, and the posteriors only under an angle of 45°. All the petals are very much narrowed towards their ends, and the ambulacral space between the poriferous zones is generally slightly higher than the adjoining interambulacral. The anus is situated at the upper, very much narrowed, bottle-shaped depression, shallowing below as its breadth increases; the lateral edges are marked with transverse irregular grooves; the margin of the periphery below the anal slit is somewhat linguiformly produced. The spines are mostly of small size, and closely longitudinally sulcated.

On the inner surface of the test the interambulacral plates are very much swollen, thick, somewhat irregularly shaped, separated by deep grooves; the ambulacral areas are depressed. Fig. 5*d* on plate V shows the great number of small plates which surround the mouth.

Localities.—Near Yermanoor, in a soft yellowish white sandstone with various Ciliopoda; at Comarapolliam and south-east of Kaudoor, in a greyish sandstone; very common at the two first named, less so at the last, place.

Formation.—Arrialoor group.

VIII. *Genus.*—CASSIDULUS, *Lamarck*, 1801.

This genus includes a great number of species, mostly of moderate or small size, ovate or somewhat angularly ovate, moderately convex above, flat below, with the oral region usually slightly depressed; apex and mouth somewhat eccentric, the former composed of four genital and five, often indistinct, ocular plates; the latter is pentagonal, surrounded by five strongly marked lobes, between which the phyllodia are well marked, composed of only two series of pores; anus at the top of a more or less oblique terminal vertical depression; ambulacra small, subpetaloid, not extending to the periphery of the test; pores simple, not yoked or connected by grooves in each series; upper surface finely granular, lower with larger tubercles and a flattened, finely granular longitudinal band through the centre.

The *Cassiduli* occur in cretaceous and tertiary deposits. They are represented in South India by four species, two of which had been described as *Nucleolites* by Forbes, who considered *Pygorhynchus* as a subgenus of it. D'Orbigny, following Agassiz, redescribed these two species under *Pygorhynchus*, and Desor, in his Synopsis (p. 299), quotes them under the same genus, although at p. 297 he distinctly maintains that the species of that genus only occur in tertiary deposits. There scarcely appears to be any difference between *Pygorhynchus* and *Cassidulus*, except that the former has the petals extending to near the periphery and the pores in each series connected by grooves, or yoked, while the petals in *Cassidulus* are shorter, sometimes almost lanceolate, and the pores are not connected by grooves. The lower surface is slightly depressed round the mouth in both genera.

Having regard to these distinguishing characters, the Indian species appear to me to be referable to *Cassidulus* and not to *Pygorhynchus*, to which they were referred by previous authors. As a peculiarity of several of the South Indian *Cassiduli*, I have to notice that the left anterior genital plate is sometimes very small or almost obsolete, without a special pore, or with only a slight indication of it, but I do not think that the character is sufficiently important to necessitate a generic separation of these species from *Cassidulus*. Agassiz described in 1869 a new genus under the name of *Neolampas* with only three genital plates, but the thin structure of the test and position of the anus, &c., conspicuously differ from other

CASSIDULINÆ. Lütken, in his Memoir on the Echinoidea in 1864, states that *Cassidulus* and *Rhynchopygus* should probably be united, as *Cass. caribbæarum* combines characters of both, but Agassiz subsequently separated that species as a distinct genus under the name *Rhyncholampas.*

1. CASSIDULUS OLDHAMIANUS, *Stoliczka.* Pl. V, Figs. 10—11.

Cass. testa late ovata, antice regulariter rotundata, postice rotundate subangulata atque paulo latiore, modice elevata, lateribus convexiusculis, ad peripheriam subobtusa, infra planata, circa aperturam paululum depressa, supra æqualiter granulate tuberculata, infra crasse tuberculifera regione mediana longitudinali granulifera excepta; apice aperturaque paulo antice eccentricis, primo tabulis genitalibus quatuor perforatis et quinque ocularibus multo minoribus composito, altera lobis quinque brevibus crassis circumdata, extus phyllodiis late ovatis alternantibus; petalis subæqualibus, antico longissimo, duobus posticis brevissimis, quoque 24—27 poros in una serie continente; regione anali profunde lateque depressa, ano rotundate ovato, spacioso, infra marginem superiorem sito, a terminatione postica fere tertiam partem totius longitudinis testæ distante.

Long. speciminis maximi 32, latit. 27, altit. 15 mm.

A very characteristic species, notably distinct from all other *Cassiduli* by a large anal depression, while the anus itself is situated near the upper narrower end of the vertical portion of the groove, and is of a largely ovate shape. The test is moderately and almost uniformly convex above, finely tuberculated, below flat and coarsely tuberculated, except along the middle, which is slightly elevated and granular, somewhat depressed round the mouth, this last being surrounded by five short but very prominent lobes, alternating with the broadly ovate phyllodia. The petals are considerably narrower towards their ends, subequal; the anterior impair one is the longest, and the two posterior are slightly the shortest; each has 24 to 27 pores in a series, and the outer pores in each are slightly more transversely elongate than the inner; the antero-laterals diverge under an angle of 140°, and the postero-laterals only under an angle of 45°, but as soon as they have passed the anus, the angle of divergence rapidly changes to 55°, the posterior part of the test being somewhat broader than the anterior, which at the front is regularly rounded. The genital and ocular plates are regularly placed, but rather difficultly discernible, except their pores.

Locality.—North of Poodoopolliam, in a somewhat ferruginous earthy limestone; not common.

Formation.—Arrialoor group.

2. ? CASSIDULUS TESTUDO, *(Forbes)*. Pl. V, Fig. 9.

1846. *Nucleolites (Pygorhynchus) testudo*, Forbes, Trans. Geol. Soc., Lond., vii, p. 161, pl. xix, fig. 2.
1847. *Pygorhynchus testudo*, Agassiz.—*idem*, d'Orbigny, Desor, et auctorum.

No specimen of this interesting species unfortunately exists in our collection, but I compared Forbes' original in 1867 and found it to agree with his description and figure. I give, therefore, a copy of both.

"N. ovatus, gibbosus, vertice supra-anali, marginibus declivibus, sulco anali "lanceolato, declivi."

"Length 1·4 inch. Breadth 1·1 inch. Height 0·7 inch.

"Oval, gibbose in the centre, with very abrupt sloping sides.

"The highest part is in the posterior (inter-) ambulacral space. The posterior "extremity slopes rapidly to the margin, and includes the long anal groove. The "dorsal ambulacra are very regularly lanceolate and stellate. The pairs of pores "are connected by grooves, which are not easily seen, either owing to the imperfec-"tion of the specimens, or from their having been originally obsolete. The under-"surface is very concave. The mouth is rather eccentric, and is surrounded by five "strong tubercles, between which radiate in star-like fashion five ovate ambulacra. "The spinigerous tubercles of the under surface are very strongly marked."

It will be seen from the above that Forbes alludes to the presence of grooves between the pores of each pair in the poriferous zones, but I could not observe them in the type, and, in spite of the rather strong concavity of the under surface, the present species is, I believe, referable to *Cassidulus*; it has not the long ambulacra of a *Pygorhynchus*.

3. CASSIDULUS EMYS, *Stoliczka*. Pl. V, Fig. 12.

C. testa elliptica, modice convexa, regione post-apicali altiore, lateribus undique gradatim et convexiuscule declivibus, ad peripheriam subangulata, infra deplanata; superficie supera minute, infera crasse tuberculifera, regione mediana infera scrobiculate granulata; apice valde eccentrico, antico; petalis subæqualibus, duobus antero-lateralibus cæteris paulo brevioribus, primis circa 24, *alteris circa* 28 *ad* 29 *paria pororum in una serie continentibus; sulco anali longo, oblique descendente, profundo, ano ad terminationem superam sito; apertura, antero-centrali, paulo immersa, margine tenui aliquanto elevato atque lobis quinque crassis, quorum duobus anticis ceteris majoribus, circumdata; ambulacris oralibus distinctis, poris in quaque serie distantibus, sed inter se approximatis.*

This is closely allied to the previous species, differing from it by having the sides of the test very gradually sloping towards the angulated periphery, the apex more anterior, the anterior petalum sub-equal to the postero-laterals, the anal furrow longer and more sloping, and the lower surface less excavated; the form of the test also appears to be somewhat more elongated, but this is not very distinctly seen in the unique, slightly injured specimen.

The apex has a very large madreporiform plate, which is, like the two posterior genital plates, largely perforated, while the perforation in the left anterior genital is very much smaller. All the petala are conspicuously contracted towards their ends, and the outer pores in each series are a trifle more transversely elongated than the inner ones, but there is no distinct groove traceable between the two pores of each pair.

Morton's *C. æquoreus* (apud D'Orbigny) is another very closely allied species, but it differs from the Indian fossil by having the apex and the aperture more central.

Locality.—Near Odium, in a brownish earthy limestone.

Formation.—Ootatoor group.

4. CASSIDULUS CRASSUS, *Stoliczka*. Pl. V, Figs. 13—14.

C. testa crassa, ovata, antice sub-rotundata, postice rapide contracta atque anguste sub-truncata, modice alta, supra fere uniforme convexiuscula, minute sed densissime tuberculifera, regione post-apicali paululum altiore, terminationem posticam versus declivi ; ambitu sub-rotundato ; facie inferiore planata, circa aperturam paulo depressa, regione mediana subrugosa, granulifera, laterali crassius tuberculata ; apice aperturaque eccentricis, paulum antice sitis : primo tabulis genitalibus tribus aperte perforatis atque quarta sinistra antica minime perforata composito, tabulis ocularibus vix distinguendis ; petalis ad terminationes vix contractis, antico longissimo, circa 34 *poros in una serie gerente, cæteris circiter tertiam partem longitudinis amb. antici brevioribus, inter se fere æqualibus, quoque circiter* 26 *poros in una serie gerente, poris externis in quoque ordine paulo longioribus quam internis, sed non jugatis ; ano ad summum sulci analis, fere verticalis, dimidium altitudinis testæ vix superantis, sito, mediocri, verticaliter ovato ; apertura pentagona, lobis quinque tuberculiformibus crassis circumdata, phyllodiis late ovatis, poris internis paucioribus quam externis.*

Speciminis maximi long. 32, lat. 21, altit. 17 mm.

The test is remarkably strong and thick, as compared with the size of this species, which is readily distinguished from other species by its peculiarly ovate shape, with an obtusely rounded periphery, being rather rapidly contracted posteriorly and narrowly subtruncate at the end; the upper convexity is almost uniform, the greatest height being a little behind the apex, but from there the surface slopes gradually towards the anal slit, which is slightly inclined or nearly vertical. The anterior left genital plate is very small and scarcely perforated, while the three others possess large openings. The anterior ambulacrum is nearly one-third longer than any of the others, which are very nearly equal among themselves, and none of them is contracted in any marked manner towards its end.

The antero-lateral ambulacra diverge, as usually, under a very large angle (about 140°), while the postero-laterals form an angle of only about 40°, which angle increases at the periphery to about 46°. The lobes round the pentagonal aperture are also unusually strong. The phyllodia ovate, having two slightly larger pores at their base, between each two lobes; all the lobes are connected by a raised margin of the aperture. Two conspicuous swellings extend from the two anterior oral lobes forward, disappearing towards the margin. The lower median granular portion of the test is also somewhat uneven, and the end is in adult specimens considerably bent downwards.

Localities.—North of Poodoopolliam, in a yellowish sandy limestone; Arrialoor and near Andoor, in a coarse sandstone; near Vailoor, in a whitish marl; tolerably common at the first, rare at the three other localities.

Formation.—Arrialoor group.

5. CASSIDULUS PLANATUS, (*Forbes*). Pl. VI, Fig. 1.

1846. *Nucleolites (Pygorhynchus) planatus*, Forbes, Trans. Geol. Soc., Lond., vii, p. 162, pl. 19, fig. 3.
1847. *Pygorhynchus idem*, Agassiz; *idem*, d'Orbigny, Desor, et auctorum.

C. testa ovata, postice paulum contracta, depresse convexa, post apicem altissima, undique convexe declivi, regione anali subtruncata, peripheria rotundate obtusa, infra subplana, medio sensim depressa, lateraliter crasse tuberculata, medio atque superficie supera dense granulatim tuberculifera; apice subcentrali, paulum antico; poris genitalibus quatuor minute perforatis; petalis ad terminationes vix contractis, antico cæteris inter se subæqualibus paulum longiore, in una serie pororum circiter 32 *paria pororum gerente, serie una petalorum lateralium poris circiter* 27 *composita, petalis antero-lateralibus angulo* 142°, *postero-lateralibus angulo* 54° *divergentibus; sulco anali fere verticali, ovato, brevi, haud usque ad marginem peripheriæ extenso, dimidium altitudinis testæ paulum superante, ano latiusculo, ovulato; apertura pentagona, lobis crassis circumdata; ambulacris oralibus elongate ovatis.*

This species is intermediate between *C. emys* and *crassus*, differing from the former by a more rounded periphery, subcentral apex, by an ovate and almost vertical anal slit; from the latter, in addition to the last character, by a more broadly ovate and more depressed shape. The lower side is not strongly but moderately concave, especially round the aperture, which is surrounded by very strong lobes, while the oral ambulacra are elongately ovate, terminating with two larger pores between each two lobes near the edge of the mouth.

Locality.—Moraviatoor, in a dark earthy limestone.

Formation.—Ootatoor group.

IX. *Genus.*—NUCLEOLITES, *Lamarck*, 1801.

The species of this genus are mostly of very small size, of a roundly ovate or squarish shape, moderately elevated and convex above; posteriorly subtruncate, below flattened and concave, with an eccentric apex and lanceolate, straight unequal petals extending to near the margin; pores not yoked or connected by grooves; anus in a superior furrow, more or less nearer the apex than the posterior end; genital pores four, ocular five; mouth eccentric, somewhat irregularly rounded or pentagonal, with the lobes either quite rudimentary or mostly entirely absent; the oral ambulacral pores are also generally very imperfectly developed.

The typical *Nucleolites* have the mouth regularly pentagonal, while those, called *Trematopygus* by d'Orbigny, have it somewhat irregularly angular and oblique, but as no other difference exists in the tests, Desor suggested to unite both under the former name. *Echinobrissus* has also a perfectly similar test, but the pores in the petals are yoked. Representatives of the genus are mostly found in cretaceous and tertiary deposits, only two or three species are known recent. In the South Indian cretaceous deposits a solitary species occurs.

Nucleolites pullatus, *Stoliczka*. Pl. VI, Fig. 2.

Nuc. testa late et depresse ovata, postice truncata, supra fere uniforme convexiuscula; apice eccentrice antico; superficie crassius tuberculata petalis lanceolatis, duobus posticis cæteris paulo longioribus, angulo 45° *divergentibus, quoque circa duodecim paria pororum exhibente, poris minimis, approximatis; ano in sulco longo profundoque sito, circa tertiam partem totius longitudinis testæ a margine postico distante; apertura eccentrica, pentagona, immersa, regione circumorali depressa, versus marginem aperturæ declivi; petalis oralibus indistinctis; superficie infera post-orali linea irregulari, paulo elevata atque minute granulata divisa.*

Speciminis majoris long. 15, *lat.* 11·5, *altitudo* 5·5 *mm.*

The peculiar broadly ovate and posteriorly truncate shape in connection with the depressed form, and the comparatively very long anal sulcus, separates the present little species from all known *Nucleolites* which I have had opportunity to compare. The tubercles are rather large as compared with the size of the test, and there is a narrow, elevated, somewhat irregular and finely granular line separating the lower posterior half of the surface and connecting the edge of the aperture with the hinder margin of the test.

Locality.—South-west of Mulloor, in a greyish sandstone; only two specimens were found, the smaller of which, being the more perfect one, is figured.

Formation.—Arrialoor group.

Family,—ECHINOCONIDÆ.

D'Orbigny, Pal. Franç. terr. cret., vi, p. 459, and Cotteau, ibidem, tome vii, p. 10.
GALERITIDÆ, auctorum, ex-parte.

This family, as defined by **Wright**, **Cotteau**, and more recent authors, adopting in part **d'Orbigny's** views on the subject, includes Echinoids of moderately large size, circular or pentagonal, hemispherical or conoid in shape, the lower surface being flattened or concave, and the upper more or less elevated; the entire surface is covered with rather small, perforated, crenulated or smooth tubercles, and intermediate very fine granules; the apex and mouth are central, or nearly so: the former composed of five genital and five ocular plates, the genital plates being either all perforated or the posterior impair one is smallest, imperforate, rarely obsolete; the mouth is on the lower side, round, or decagonal, with slight incisions and internally provided with jaws; ambulacra narrow, continuous from the apex to the mouth, composed of very small, equal pores; interambulacra broad. The position of the anus is very variable, always eccentric, either on the upper or on the lower side, or sub-marginal. The spines are generally small and thin, longitudinally sulcated.

Cotteau (*l. cit.*) restricts the family to six genera, *Echinoconus*, *Discoidea*, *Holectypus*, *Anorthopygus*, *Pileus*, and *Pygaster*, all of which are extinct, occurring in jurassic and cretaceous deposits. Of these only *Echinoconus* with two and *Holectypus* with one species find representatives in the South Indian cretaceous deposits.

The closely allied *ECHINONEIDÆ*, of which the typical genera *Echinoneus* and *Pyrina* were by **d'Orbigny** also referred to the present family, and of which some forms are still found living, differ by their mostly somewhat elongate or ovate shape; the apical disc is composed of only four genital plates, the peristome is mostly irregularly pentagonal without incisions, and there are no jaws present. The only other allied family are the *COLLYRITIDÆ* or *DYSASTERIDÆ*, the members of which have an elongate apical disc, the ambulacra meeting at two points; they also have no jaws, and the mouth is eccentric.

Some of the *ECHINOCONIDÆ* show in external shape a very marked resemblance to the *ECHINIDÆ*, both in form and ornamentation of the test, and in the central position of the mouth with its incisions in the peristome.

X. *Genus.*—ECHINOCONUS, *Breynius*, 1732.

D'Orbigny, Pal. Franç. terr. cret., vi, p. 496.
Galerites, **Lamarck** et auctorum.

Test of moderate size, hemispherical or conoid, covered with small, submammillated, crenulated and perforated tubercles, intermediate space finely granular; apex subcentral, composed of four perforated and one (the posterior) smaller and imperforated genital, and five ocular plates; ambulacra radiating from the apex, continuous, the pores in each pair very close to each other; aperture central or very nearly so, decagonal; anus marginal or inferiorly sub-marginal.

All the species as yet known are from cretaceous deposits, particularly the middle and upper series of that formation.

D'Orbigny's remonstrance against introducing Lamarck's name *Galerites* for *Echinoconus* of Breynius has now, I believe, been almost generally acknowledged as just, and the latter name adopted. Desor in his Synopsis attempted to retain both, but the division is, I think, not admissible.

Two species of the genus occur in the South Indian cretaceous deposits.

1. ECHINOCONUS *conf.* CONICUS, *Breynius*. Pl. VI, Fig. 3.

Vide d'Orbigny, Pal. Franç. terr. cret., vi, p. 513, pl. 996 and 997, figs. 1—7
Galerites albogalerus, auctorum.

The accompanying illustration will indicate better than a lengthened description the probability with which the single Indian example can be referred to the well known European species. This, although closely allied to several other upper cretaceous forms, is distinguished from most of them by its very markedly elevated shape and the broad, flattened under-surface with a rather narrowly rounded periphery. In the Indian example these characters are tolerably well marked. The broadly conoid form with a somewhat rapidly attenuated apex is quite identical with the variety, first distinguished by des Moulins and Desor as *Galerites pyramidalis*, and described by d'Orbigny as *Echinoconus subpyramidalis*, (compare d'Orbigny, l. cit., p. 530, note by Cotteau). This form is, however, acknowledged to represent a mere variety of *E. conicus*, to which also, I should say, *E. subconicus*, d'Orb., is undoubtedly referable.

The divergence and breadth of the ambulacra, the size and submarginal position of the anal opening of the Indian specimen, exactly agree with the same characters in the European form; the tubercles are slightly larger below than above, but the lower side, especially round the oral opening, is partially broken, or pressed in, in the Indian example, so that the exact shape of the mouth cannot be traced.

This circumstance makes the identification somewhat uncertain, though a mere glance at the figures will show that it is highly probable.

Locality.—Near Comarapolliam, in a whitish, conglomeratic sandstone.

Formation.—Arrialoor group.

2. ECHINOCONUS PLACENTULA, *Stoliczka*. Pl. VI, Fig. 4.

E. testa subdiscoidea, subrotundata, supra convexiuscula, regione post-apicali paululum gibbosula, infra plana, aliquanto crassius tuberculifera quam in superficie supera; apice aperturaque centralibus, primo paululum deplanato, altera decagona, modice spaciosa; zonis poriferis angustissimis, poris minutissimis, ad peripheriam vix distinguendis, instructis, infrá versus aperturam depressiusculis; regione anali paulo contracta atque producta; ano marginali, ovato, obliquo, aliquanto descendente.

This is one of the most depressed species of *Echinoconus* known; the test is slightly gibbose behind the apex, curving more strongly towards the posterior, and slightly produced, than towards the anterior end. The lower side is flat, with fine grooves indicating the poriferous zones, the pores in them being so small as to be hardly distinguishable. The mouth is rather larger and the anus more marginal, and more distinctly indicated in an upper view than in any other species known.

Locality.—Karapaudy, in a whitish coarse sandstone; only the figured specimen has been examined.

Formation.—Arrialoor group.

XI. *Genus.*—HOLECTYPUS, *Desor,* 1842.

Desor, Synops. Echin. foss., 1858, p. 168.
Cotteau, Pal. Franç. terr. cret., vol. vii, p. 42.

Test of small or moderate size, discoid or roundly pentagonal, upper side convex, highest at the apex, which is central, lower convexly flattened, concave towards the centre, in which the mouth is situated; the latter is decagonal, with two incisions in the margin of each interambulacrum and with jaws internally; tubercles of the surface small, perforated, crenulated, with intermediate granules; apex composed of five ocular and five genital plates, the anterior right is, as usually, largest and madreporiform, the posterior plate is sometimes imperforated and smaller than the rest; ambulacra continuous, composed of very small closely set pores in oblique pairs; anal opening ovate or pyriform, inferiorly marginal, very large, with a simple margin; spines small, marked with longitudinal striæ.

Holectypus is an entirely extinct genus, occurring in jurassic and in cretaceous rocks, the species being more numerous in the former than in the latter. It is very closely allied to *Discoidea,* differing from it by the absence of any internal ridges at the periphery, and by having the anal opening mostly of a large size. All the cretaceous species have the apical disc composed of five perforated genital plates, while in the jurassic species only four are perforated, and the hinder impair one small and imperforated, or sometimes almost obsolete.

There are ten species of *Holectypus* known from cretaceous deposits.

1. Holectypus *sp. indet.* Pl. VI, Fig. 5.

The single specimen does not admit of a good characteristic being given, but it seems to belong to an undescribed species. The test has greatly suffered from lateral pressure, but the general form very closely approaches to that of *H. crassus* and *serialis,* (compare Cotteau, l. cit., pp. 55 and 59, pl. 1017). The Indian fossil seems to be slightly less elevated than the former, but slightly more than the latter, the granulations of the surface and the width of the ambulacra agree better with *serialis,* the mouth appears to be, however, wider than in either of the two.

The apex is entirely broken away, and of the original margin of the anal opening only one side is preserved. It would be very interesting to obtain better preserved specimens of this species, in order that a proper comparison with the European and African upper cretaceous *H. serialis*, Desh., might be instituted.

Locality.—South-west of Mulloor, in a coarse slightly ferruginous sandstone.

Formation.—Arrialoor group.

Family,—SALENIDÆ.

Comp. Cotteau, Pal. Franç. terr. cret., vii, p. 82, and Wright, Brit. Cret. Echinod., p. 144, in vol. xxiv of Palæont. Soc.

This family includes a moderately large number of mostly small sized species with the apical disc very largely developed, consisting of five smaller ocular, five larger genital plates, and in the centre of the latter is a special sur-anal plate, either single or divided into several pieces. This great development of the apical disc distinguishes the *SALENIDÆ* from the *CIDARIDÆ* and allied families.

The test is generally moderately convex, with the poriferous zones narrow, straight, or slightly undulating, the pores being distributed in single pairs. The ambulacral areas are much narrower than the inter-ambulacral; each plate of the former has a granular tubercle, and besides that sometimes a few very fine granules; on the ambulacral plates the tubercles are much larger, and the granules are generally of two sizes, the larger round the areolæ, the miliary ones along the inner sutures. The upper edges of the tubercular bosses are crenulated, and the knobs perforated or imperforated. The mouth is roundly hexagonal, more or less deeply notched; the anal opening is eccentric.

The spines are very variously shaped in the different genera, and smooth, or more or less granular.

The *SALENIDÆ* are mostly characteristic of the secondary deposits, occurring from the middle jurassic to the uppermost cretaceous strata; a few are eocene, and one or two species recent.

Six genera are usually distinguished—

A. Ambulacra large, straight; surnanal plate compound.
    1. *Acrosalenia*, with the tubercles perforated.
B. Ambulacra narrow; surnanal plate single; anus external and posterior.
  a. With the tubercles perforated.
      2. *Pseudosalenia*; anus axial.
      3. *Heterosalenia*; anus extra-axial.
  b. With the tubercles imperforated.
      4. *Goniophorus*; anus axial, and ambulacra with poriferous impressions.
      5. *Peltastes*; anus axial, without poriferous impressions in the ambulacra.
      6. *Salenia*; anus extra-axial.

Of these genera only one is represented in the South Indian cretaceous deposits with a single species.

XII. *Genus.*—SALENIA, *Gray*, 1835.

The *Saleniæ* are mostly cretaceous, occurring from the lowest to the highest strata; very few species are from tertiary beds.

1. Salenia Arcotensis, *Stoliczka.* Pl. VI, Fig. 6.

S. testa parva, circulari, modice hemispherica, disco apicali late conoideo, permagno; tabulis genitalibus late perforatis, radiatim costulis subgranulosis ornatis; tab. ocularibus magnis, trigonis, anguste perforatis, ad marginem externum incrassatis, margine mediano paululum insinuatis; ambulacris angustissimis, tuberculis submammilatis, circiter 14, *lævigatis, valde approximatis, in area mediana granulis minutissimis separatis instructis; zonis poriferis bigeminatis, fere rectis. Zonis interambulacralibus latis, tuberculis primariis biserialibus circiter octo, inæqualibus; quaque tabula ad angulum externum unigranosa, interne prope areolam granis* 3-4 *majoribus, ad marginem pluribus minoribus subæqualibus instructa.*

A small species, with a rather depressed, circular test and a very large, broadly conoid apical disc, which slightly overlaps the edges of the test, as is usually in *Peltastes* and *Salenia*. The anus is small, sub-elliptical, situated without the axis of the animal; the mouth comparatively very large, with small but distinct incisions in the margin. The base is slightly convex.

The suranal plate appears to be nearly smooth, indented by the anal opening at the posterior right angle. Each of the genital plates is subcentrally pierced by a rather large ovoid opening, surrounded by a thickened margin, from which radiate indistinctly granulated ribs, or rows of granules; in the madreporiform plate the opening is narrowly elongated towards the axis. Each of the ocular plates is subtrigonal, with a small almost central pore, in the middle of the external margin slightly indented, while the corner margins are strongly thickened, and almost tubercular. There is also a small pore present in the middle of the suture between each two genital or ocular plates and also in each corner, whenever three of the plates meet.

The ambulacral zones are very narrow, with about fourteen pairs of alternating, closely set, smooth tubercles, a few of them towards the mouth are conspicuously larger than the rest; the two series are separated by very minute subequal, densely set granules. The poriferous zones are nearly quite straight, and there are twenty-five oblique pairs of pores in each series. The interambulacral area is very broad, with two rows of primary tubercles, the two upper ones in one row, and the two middle ones in the other being the largest; the boss is regularly conoid, smooth, strongly crenulated on the upper margin; the mammelon hemispherical, comparatively rather small, smooth, imperforate. Each ambulacral plate has one granule at each corner of the poriferous side, and three or four along the areola on the opposite side, and there are besides on the miliary zone numerous very small granules, again differing in size among themselves.

In structure, namely, the number and form of tubercles on the ambulacral and interambulacral zones, the present species rather closely resembles the well known *Salenia scutigera*, Gray, but differs from it, and, as far as I have been able to make comparisons of figures and descriptions, from all other known species by the comparatively small height of the test, the large broadly conoid disc, and the wide mouth.

Locality.—Comarapolliam, in a coarse sandstone; only the figured specimen was examined.

Formation.—Arrialoor group.

Family,—ECHINIDÆ.

Comp. Cotteau, Pal. Franç. terr. cret., vol. vii, p. 808.

The *Echinidæ*, as originally defined by Wright, and afterwards restricted by Cotteau, include a large portion of the Latistellate group of the old family *CIDARIDÆ*. They have a rather spheroidal test; their ambulacral areas vary in width, and each plate, as also those of the interambulacral areas, is provided with several comparatively small primary tubercles, these being perforate or imperforate, and with the upper edge of the bosses crenulated or smooth; the poriferous zones have the pores in pairs, or in more numerous series, and always more or less irregular. Mouth of moderate size, the margin with ten incisions. Buccal membrane naked, or covered with small scales, irregularly arranged. Anus central, situated between the five genital and five ocular plates, one of the former being united with the madreporiform plate. Spines mostly short, subcylindrical, or subulate, generally marked with fine longitudinal, subgranular striæ.

When compared with the *CIDARIDÆ* the members of the present family are easily distinguished by the width of the ambulacral areas and the development of distinct primary tubercles on them, as also by the incisions of the apertural margin.

The difference is, however, much less pronounced between the *ECHINIDÆ* and the *DIADEMATIDÆ*, particularly in those divisions in which the primary tubercles on the ambulacra are comparatively small and numerous, and where the poriferous zones are multigeminal, but even in these few very closely related genera, the *ECHINIDÆ* show, as a rule, a more marked irregularity in the relative position of the pores.

Cotteau divides the family into two groups, according to the tubercles being (1) perforated or imperforated, with the bosses crenulated, or not perforated and crenulated, or (2) with the tubercles neither perforated nor crenulated. Of the 36 genera of which abbreviated characteristics are given, only one occurs in South India, and is represented by a single species from the uppermost cretaceous beds.

The *Echinidæ* are known from the beginning of the middle jurassic deposits up to the present time, gradually increasing in number and richness of forms. In the jurassic deposits five genera occur, in the cretaceous seven, in the tertiary twelve, and the remainder in the present epoch, in addition to seven genera which are found both in fossil and recent state.

XIII. *Genus.*—MICROPEDINA, *Cotteau*, 1866.

Cotteau, Pal. Franç. terr. cret., vol. vii, p. 822.

Test of moderate size, inflated, with the primary tubercles numerous, arranged in transverse, almost parallel series, equal on both the ambulacral and interambulacral areas, slightly prominent, smooth and perforated; poriferous zones narrow, with the pores in single pairs, almost regularly placed under each other, and in three pairs to each ambulacral plate. Peristome round, with small incisions. Anus rather large, subelliptical, surrounded by the five genital plates and much smaller ocular plates, both being finely granular.

These characters readily distinguish the present genus from all other *Echinidæ*. There is as yet only a single species known from the Senonien beds of Algeria, *M. Cotteaui*, Coquand.

1.—Micropedina sphæroides, *Stoliczka*. Pl. VI, Fig. 7.

M. testa sphæroidali, infrâ paulum convexiuscula; aperturâ parva, incisionibus marginalibus brevibus instructa; zonis poriferis angustis atque rectis, poris regularibus, approximatis; tuberculis ambulacralibus interse æqualibus, atque in superficie supera paulo minoribus quam in infera, quaque tabula ambul. ad peripheriam tuberculis primariis quatuor, quaque tabula inter-ambul. tub. decem in ordine singulo ornata, tuberculis perforatis, modice elevatis, areolis distinctis polygonis circumdatis, interspatiis minutissime crenulatis.

Test somewhat depressedly spheroidal, with the base slightly convex, and the aperture comparatively very small, circular, and with short but distinct incisions. The poriferous zones very narrow, straight from the apex to the aperture, with the pairs of pores regularly placed under each other, only the lowest pair opposite each ambulacral plate is somewhat inwardly situated, and sometimes, though very rarely, there is a third pore added to the two others In the figured specimen the test is only preserved on the lower side, but in another smaller specimen, which to all appearance belongs to the same species, the pores are equally regular on the upper side as they are on the lower. The width of the ambulacra at the periphery is two-fifths of that of the interambulacra, the primary tubercles on both quite equal, slightly larger on the lower than on the upper side. At the periphery there are four alternate primary tubercles on each ambulacral plate, and about ten on each interambulacral plate, the last three or four somewhat obliquely descending towards the poriferous zone. Towards above and below the number of tubercles of course decreases. The mammelon is rather depressed, smooth, perforated; the boss ring-like and scarcely elevated above the outer edge of the otherwise distinctly marked, roundly polygonal areola, the edges of which when well preserved form rather sharply crenulated, almost straight lines between the tubercles, while the interspaces between the horizontal rows of tubercles are broader and uniformly very finely granular.

The only specimen which distinctly exhibits the characters of the genus is, as already stated, not so far preserved as to render a perfect characteristic of the species possible, but it can be readily distinguished from *M. Cotteaui* by the much smaller aperture, much greater number of tubercles on the interambulacra, and the finely granular surface between them.

Locality.—North of Poodoopolliam, in a white, impure limestone, together with *Terebratula subdepressa*. The small specimen above referred to is from a light brown calcareous sandstone south-east of Kullay.

Formation.—Arrialoor group.

Family,—DIADEMATIDÆ.

Cotteau, Pal. Franç. terr. cret., vol. vii, p. 368.

Wright, HEMICIDARIDÆ and DIADEMADÆ (ex parte).

The test is in this family hemispherical or depressed, and rounded or subpentagonal; the ambulacra are wide, and the poriferous zones narrow, straight, or undulating, and generally with the pores in simple pairs, placed regularly under each other; more rarely do the series of pores increase on the upper side of the test, but they never show that great irregularity in position which is commonly observable in the *ECHINIDÆ*. The primary tubercles on both the ambulacral and interambulacral areas are bi- or multi- serial, on the latter sometimes of unequal size, and often slightly larger than on the ambulacra; they are either perforated or imperforated, and crenulated or smooth. Secondary tubercles are, as a rule, well developed. The apical disc is small or of moderate size, composed of five genital and five ocular plates; the upper right genital plate has madreporiform structure, and is usually somewhat larger than the others. The anus is central; the mouth divided by ten incisions at the margin, a character by which the members of the present family are readily distinguished from the *CIDARIDÆ*. The buccal membrane is covered with small unequal plates, irregularly disposed; the dental apparatus composed of strong teeth.

The spines are elongate, aciculate, cylindrical, or more rarely somewhat clavate, almost smooth or longitudinally striated, or with rows of granules, but they never are spinous.

There can be no difficulty in distinguishing the DIADEMATIDÆ from the CIDARIDÆ by the incisions on the apertural margin alone, but the ECHINIDÆ only differ by a more irregular position of the pores, though their usual more spheroidal shape, and great number of comparatively small primary tubercles, generally admit of recognising the members of that family with tolerable accuracy.

Cotteau gives short characters of thirty-one genera, to which a few fossil and recent ones, suggested by Woodward, Agassiz, and others, have to be added. The same author sub-divides the family into four groups according to the character of the tubercles :—

1. With the tubercles perforated and crenulated, type *Hemicidaris.*
2. „ „ „ „ and non-crenulated, „ *Cidaropsis.*
3. „ „ „ imperforated and crenulated, „ *Cyphosoma.*
4. „ „ „ „ and non-crenulated, „ *Goniopygus.*

Out of the thirty-five genera known, two are represented in the South Indian cretaceous deposits, namely, *Pseudodiadema*, belonging to the first, and *Orthopsis*, to the second group.

The distribution of the DIADEMATIDÆ in time extends from the lowest secondary deposits into the present epoch, attaining its greatest development in the cretaceous period, both as regards generic as well as specific forms.

XIV. *Genus.*—PSEUDODIADEMA, *Desor*, 1856.

The test is always more or less depressed, round or pentagonal, the ambulacral areas are conspicuously narrowed towards the apex, and the poriferous zones widened and multigeminal on the upper side. The primary tubercles are nearly equal on the two areas and in from two to five or six vertical series, with secondary tubercles interspersed; they are perforated and crenulated on the upper margins of the bosses. The apex is usually of larger size, and the plate composing it of tender structure; the consequence being that it is very often lost in fossil specimens, exposing a large pentagonal opening. The apertural margin is more or less distinctly decagonal. The spines are cylindrical or slightly compressed, or aciculate, nearly smooth, but usually a fine longitudinal striation is observable with the lens.

The *Pseudodiademata* are distinguished from other allied genera, such as *Hemicidaris* and *Acrocidaris*, by the multigeminal pores near the apex *(Diplopodia*, M'Coy, Desor), largely developed apical apparatus in connection with the depressed shape of the test, and also by the very slight difference in the size of the ambulacral and interambulacral tubercles, which are of nearly equal size in the entire extent of the two areas.

The species of *Pseudodiadema* are the most abundant of the whole family, and occur both in jurassic and in cretaceous deposits; they were believed to have disappeared with the uppermost strata of the latter formation, but some recent species, lately discovered in America, are stated to belong probably to this genus.

In the cretaceous rocks of South India we have three representants, only one of which, however, admits of a sufficiently recognisable characteristic being given. They are all from the uppermost beds of the cretaceous series, the Arrialoor group.

1. PSEUDODIADEMA SUBANGULATUM, *Stoliczka.* Pl. VI, Fig. 8.

Ps. testa rotundate subpentagona, ambulacris ad peripheriam paulo projicientibus, valde depressa, supra deplanata, infra lente convexiuscula; tuberculis in areis ambulacralibus biserialibus, alteris conspicuiter majoribus, in interambulacris sixserialibus, seriebus duabus internis maximis, externis multo minoribus, haud usque ad marginem apicalem continuis, omninis crenulatis, mammillis depresse globosis atque perforatis instructis, interspaciis undique minute granulatis; zonis poriferis infra et ad peripheriam bigeminatis, regularibus, supra versus marginem apicalem alternantibus, rare trigeminatis. Area apicali magna, pentagona; apertura mediocri, rotundata; altitudine testæ circa tertiam partem diametri æquante.

This species appears to have its closest ally in the European *Ps. variolare*, Cott., from Cenomanien beds. It is, however, readily distinguished from it by its distinctly pentagonal shape, a wider apical opening, and by the three rows of tubercles on each series of interambulacral plates being better developed. The outermost of these rows on either side is composed of the smallest tubercles, which disappear shortly after they reach the upper surface of the test above the periphery; the next row of tubercles on either side reaches very nearly, and the two median rows fully to the apical margin; the last are also parallel to each other, while in *Ps. variolare* the two median rows are divergent and the two outer ones much shorter. The ambulacral tubercles are prominent, and slightly larger than any of the interambulacral ones. The interspaces are finely granular. There is no essential difference in the poriferous zones, on the upper side of which the pairs of pores are alternating, and very closely following each other. The apical disc is lost in the single specimen, but the opening is rather a large one, pentagonal, slightly longer than broad. The aperture is also moderately large and rounded.

Locality.—Karapaudy; a single specimen in a whitish sandstone.

Formation.—Arrialoor group.

2. PSEUDODIADEMA *sp. indet.* Pl. VI, Fig. 9, and Pl. VII, Fig. 1.

A single specimen in the collection evidently belongs to a peculiar, highly ornamented species, of a somewhat depressedly hemispherical shape above, and slightly rounded below, but it is so imperfect that no reliable characteristic can be drawn up by which the species could again with facility be recognised.

The alternating position of the pairs of pores on the upper side, and the rather large opening for the apical disc, clearly indicate that the species belongs to the present genus. The general form and ornamentation exhibit a great resemblance to those of *Ps. pseudo-ornatum*, Cotteau,* from the Cenomanien. The primary tubercles form only two rows on both the ambulacral and interambulacral areas, and are about equally strong, and both below towards the mouth as well as above towards the apical disc they very much diminish in size. The areolæ are large and smooth in both cases; each ambulacral plate has the areola surrounded by a row of sub-equal granules, while on the interambulacral plates these granules are more numerous and of three sizes, the largest on the outer side, approaching to form a row of secondary tubercles.

I have given three views of the fragmentary specimen which may be of assistance in a subsequent search after this interesting fossil.

Locality.—Mulloor, in a coarse, almost conglomeratic sandstone.

Formation.—Arrialoor group.

A second, also an imperfect specimen, is from the Arrialoor sandstone near Arrialoor. It evidently belongs to a species distinct from the previous, differing from it by comparatively larger primary tubercles, which are equal on the ambulacra and interambulacra, by a somewhat smaller oral opening and by more distinctly undulating poriferous zones. It is possible that this specimen may belong to *Hemicidaris*, but much better materials are required to ensure even a reliable generic determination. Comp. figs. 1, 1*a*, 1*b* on Pl. VII.

XV. *Genus.*—ORTHOPSIS, *Cotteau*, 1863.

Pal. Franç. terr. cret., vol. vii, p. 550.

Test of moderate size, somewhat depressed, poriferous zones narrow, with the pores throughout in simple, regular pairs, each two pores in a pair separated by a granular elevation. Primary tubercles in two or more series, and of sub-equal size on the ambulacra and interambulacra, with granules between them, as in *Pseudodiadema*; they are also perforated, but the bosses are not crenulated on the upper edge. Aperture rounded, with distinct incisions on the margin. Anus somewhat irregularly rounded, of moderate or small size, surrounded by the granular plates of the apical apparatus.

Cotteau refers four species to this genus, all from cretaceous beds, to which *Orthopsis* appears to be restricted. The regularity of the pores and the smoothness of the bosses readily separate the genus from *Pseudodiadema.*

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* Pal. Franç. terr. cret., vol. vii, pl. 1116, figs. 5—15.

Orthopsis similis, *Stoliczka*. Pl. VII, Fig. 2.

Or. testa subpentagone rotundata, depresso-hemispherica, infrá fere plana; tuberculis primariis ambulacralibus et interambulacralibus biserialibus, primis circa 18-20 *in quaque ordine, area intermedia granulis numerosis instructa, alteris paulo majoribus, undecim in una serie, abbreviate conoideis, mammellis parvis, depressis, spaciose perforatis; quaque tabula interambulacrali tuberculo secundario majore ad angulum internum superiorem et altero paulo minore ad angulum exteriorem sito instructa, tub. ambobus brevissime mammillatis atque perforatis, superficie reliqua granulis numerosis inæqualibus notata, granulo in angulo externo inferiore sito maximo sed non perforato; zonis poriferis modice angustis, poris bigeminatis circiter* 56 *in una serie; apertura rotundate decagona, lata, tertiam partem diametri superante; tabulis apicalibus indistincte granulosis; orificio anali irregulariter tetragona, angulis subrotundatis prædito.*

This is a well marked species of the rare genus *Orthopsis*, and although very closely allied to the Cenomanien *Orth. granularis*,* (Ag. and Des.), this last is readily distinguishable by the smaller number of granules on both the ambulacral and interambulacral plates; the latter are also distinctly higher in proportion to their length.

Orth. similis has a nearly round shell, but as the ambulacra, in spite of their tubercles being a little smaller than those of the interambulacra, slightly project beyond the periphery of the latter, there is at least an approach to pentagonal shape; the upper side is depressedly hemispherical, the lower nearly flat, and the height exceeds half the diameter of the shell by one millimeter. There are 56 regular pairs of pores in one zone; only towards the aperture there is a very slight irregularity observable in position. On the ambulacra are eighteen to twenty tubercles in one row, on the interambulacra only eleven. Each of the latter plates has, however, two unequal mammillated and perforated secondary tubercles in each of the upper angles, one large granule in the lower outer corner, and the rest of the surface round the groove-like areola is rather numerously unequally granular, at least considerably more so than in *O. granularis*.

The apical plates are indistinctly granular, as in the latter species, and do not offer any peculiarity, but the anal opening is more irregularly quadrangular. The mouth is rather large, its width being about two-fifths of the total diameter.

Locality.—North of Chokonadapooram; two specimens in an impure, sandy, reddish or pinkish limestone.

Formation.—Arrialoor group.

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* Cotteau, Pal. Franç. terr. cret., vii, p. 554, pl. 1130.

Family,—CIDARIDÆ.

Cidaridæ angustistellatæ, auctorum.

The CIDARIDÆ have generally a rotiform test, with a large opening for the apical apparatus, a moderately sized anal and large oral opening, the latter round or somewhat angular, but without any incisions; the buccal membrane is scaly and the poriferous zones continue on it; they are straight or slightly undulating; in each series the pores are generally in simple pairs. The ambulacra are very narrow, provided only with granules, but never with primary tubercles, of which (with a single exception) two rows occur on each interambulacral area; they are perforated, surrounded by a distinctly developed areola, the edge of which is very often provided with a row of more or less distinctly mammillated secondary tubercles or granules, which are larger than those on the rest of the surface of each plate. The apical apparatus consists of five genital and five ocular plates, the right anterior of the former plates possessing, as usually, madreporiform structure.

The form of the spines is very variable, from cylindrical or fusiform to club-shaped or flattened; they are longitudinally striated, and often granular or spinose; the amount and details of ornamentation appear, however, to be subjected to considerable variation not only in the different species, but also in different stages of age of the same species, and even on different portions of the same shell.

The members of this family, which occur both fossil and recent, are readily distinguished from the other divisions of the *Echinoidea endocyclica* by the very narrow ambulacra, devoid of primary tubercles, and by the entire margin of the aperture.

Cotteau classifies the CIDARIDÆ in two groups, the first with eight genera comprising the typical forms of the family, with only two rows of primary tubercles on each interambulacral area, and the second with the solitary genus *Heterocidaris*, an oolitic form, with more than two rows of tubercles on the same area. We have in South India only the genus *Cidaris* represented, and although four or five different species are indicated, none is unfortunately in a state of preservation which would permit of a thoroughly satisfactory specific definition, but several appear to be identical with known European species.

XVI. *Genus.*—CIDARIS, *Klein*, 1734.

Test subcircular, more or less elevated and depressed from above and below, ambulacra nearly straight, with two or more rows of granules; poriferous zones narrow, subflexuous, the pores in each pair usually separated by a granular swelling; interambulacra with large, perforated or not perforated, primary tubercles. Apical disc subpentagonal or rounded, with a pentagonal anal opening; aperture large, rounded; spines very variable in shape, ridged or granular.

The genus *Cidaris* extends from the Trias (if not from the carboniferous) through all the successive formations, and is even in the present seas numerously represented. In South India the following species are indicated.

1. Cidaris hirudo, *Sorignet*. Pl. VII, Figs. 3—16.

Cotteau, Pal. Franç. terr. cret., vol. vii, p. 244, pl. 1054 *bis*, figs. 6-16.

This species is represented by a great number of spines and a few plates, both agreeing in every respect with similar portions of the test described and figured by Dixon and Cotteau. The ambulacral areas have six rows of granules, the outermost on each side being the largest, and between the inner rows some smaller granules are irregularly interposed. Each two pores of the narrow poriferous zones are separated by a small granule, superseded by a short groove. The primary tubercles of the interambulacra have rather low, small, perforated mamelons, and the bosses with smooth, sharp edges surrounded by large areolæ. The margin of the latter is provided with from 16 to 18 mammillated granules, and the rest of the surface of each ambulacrum with small, densely set, round or slightly elongated granules, between which occasionally some very minute ones are interposed.

The spines have always a more or less distinct fusiform shape, with a slender, tolerably long neck, inflated about or above the middle, then somewhat attenuated and truncated at the end. The margin of the articular cavity is conspicuously crenulated; the head very minutely striolated, somewhat coarser on the milled ring itself than above it. The stem is surrounded by numerous longitudinal ribs, more or less distant from each other, and with shorter and longer ribs interposed between the others; they are generally granular, but the granules are almost invariably better developed on the basal than on the terminal portion of the stem, and near the neck they are occasionally dissolved into simple rows of granules. Rarely more than eight to twelve of the principal ribs extend to the tip of the stem, where they form a kind of rosett, with a few unequal granules in the impressed centre. The interspaces between the ribs are regularly finely shagreened.

Locality.—Moraviatoor, in brownish marly limestone.

Formation.—Ootatoor group.

Cidaris hirudo is a well known and widely spread species in the Cenomanien and lower Senonien beds of France and England. Forbes first noticed it as a variety of *sceptrifera* and subsequently proposed to call it *sulcata*, but Sorignet's name has priority.

2. Cidaris *conf.* vesiculosa, *Goldfuss*. Pl. VII, Figs. 21—24.

Cotteau, Pal. Franç. terr. cret., vol. vii, p. 222.
Wright, Mon. Brit. Cret. Echinodermata, p. 41.

A few spines of a rather slender, subfusiform shape appear to belong to this species. They have a small articular cavity, with a crenulated edge, like those of the preceding species, but the neck is more slender and smooth; the longitudinal ribs are more equal in length, in their entire extent pointedly granular, the interspaces are only slightly broader than the thickness of the ribs and distinctly shagreened.

These differences will be readily observed from a comparison of the accompanying figures.

Locality.—Moraviatoor, in earthy limestone.

Formation.—Ootatoor group.

This geological position exactly corresponds to that in which *C. vesiculosa* is found in Europe; it is one of the most common, widely spread and characteristic species of the Cenomanien beds with *Scaphites æqualis*, *Amm. rostratus*, *&c.*

3. CIDARIS *conf.* SUB-VESICULOSA, *d'Orbigny.* Pl. VII, Figs. 17—20 & 25—28.

Cotteau, Pal. Franç terr. cret., vol. vii, p. 257.
Wright, Brit. Cret. Echinod., p. 57.

A few plates and spines exhibit considerable resemblance to the above species. The ambulacra have four closely set granules, which are reduced to two near the aperture and the apex, but they appear to be, as are also the poriferous zones, more distinctly undulating than in *sub-vesiculosa*. The interambulacral plates are also similar in size, both as regards the form of the tubercles and the granulations of the miliary zones, but the areolæ are a little smaller than represented in Cotteau's figure of that species, agreeing, however, with those figured by Dr. Wright. The spines equally agree with those of *sub-vesiculosa* in their slender shape, proportionately large head, and numerous granular ribs, with narrow, shagreened interspaces, but unfortunately none of the spines is preserved in its entire length, and the granules on the ribs were either originally smaller or they appear to become much more easily worn off, than is the case in the European species. Although it is possible that the above noted differences indicate a form specifically distinct from *C. sub-vesiculosa*, the latter is the only species with which the Indian fossil can be compared; and it is after all not improbable that the differences indicated only refer to an individual variation.

Locality.—Moraviatoor, in company with the two preceding species.

Formation.—Ootatoor group.

C. sub-vesiculosa is a common species of the Turonien and Senonien beds both in England and on the Continent of Europe.

4. CIDARIS *conf.* FARINGDONENSIS, *Wright.* Pl. VII, Figs. 29—30.

Wright figures (Monog. Brit. Cret. Echinod., pl. ii, figs. 6—8,) under the above name two interambulacral plates and three spines. The latter have an elongately cylindrical shape, ornamented with longitudinal, spinulously granular ribs, separated by rather wide, shagreened interspaces; they differ conspicuously from the spines of other known *Cidaris* by the great length of the neck, which is longitudinally very finely striated, and at the upper end abruptly separated by a raised ring from the ribbed and granular body. This peculiar character is indicated in a few imperfect fragments of spines from

Locality.—Moraviatoor, the specimens having been found in the society of *C. hirudo.*

Formation.—Ootatoor group.

C. Faringdonensis is said to be from the Lower Greensand of Faringdon, but it is probable that at least a portion of these beds represents a higher horizon, because *Ter. depressa*, Lam., occurs in them, and which is also found in the Ootatoor beds of South India.

5. CIDARIS SCEPTRIFERA, *Mantell.* Pl. VII, Figs. 31—36.

Cotteau, Pal. Franç. terr. cret., vol. vii, p. 251.
Wright, Brit. Cret. Echinod., p. 54.

Of this species only one interambulacral plate, with a portion of the poriferous zone and the half width of the corresponding ambulacral area, besides a great number of spines, were found preserved. The ambulacral area has near the periphery eight rows of granules, which are gradually reduced to two at the apex; those of the outermost rows are submammillated and larger than the next, but of nearly the same size as those in the following row. The poriferous zones are slightly flexuous, and the pores lie in distinct grooves. The tubercles of the interambulacra are of moderate size, with rather extensive miliary zones; the row of about 16 mammillated granules round the areola is very distinct, but the next surrounding row is not well defined. The interambulacrum figured on pl. vii shows a slight depression near the upper margin, which is also traceable on the plates following those in contact with the apical disc of adult specimens, as the one figured by Wright (l. c., pl. vi, fig. 1).

The spines are of the usual elongately fusiform shape, being moderately inflated in the basal third, and then gradually attenuated towards the truncated tip. They are ornamented with numerous longitudinal, spinulously granular ribs, separated by shagreened depressions; sometimes the granules become irregularly arranged about the middle of the length of the body of the spine. The neck is short, very finely striated, and the head is also short, with a moderately prominent milled ring.

In all these characters the spines of the Indian specimens, as well as the single interambulacral plate in its largely developed miliary zone, agree with the typical original English specimens, while the form of the test figured by Cotteau from

France is more depressed, retiform, the areolæ of the interambulacra larger, and the miliary part much smaller; the spines also appear to have slightly longer necks. Whether these differences indicate an individual or a specific distinction, I am unfortunately not in a position to say for want of materials.

Locality.—Olapaudy, in a marly, slightly oolitic rock.

Formation.—Arrialoor group.

C. sceptrifera is one of the most characteristic and widely-spread fossils of the uppermost cretaceous deposits, Senonien, White Chalk, Oberer Plæner, etc.

CIDARIS *n. sp.* Pl. VII, Fig. 37.

A single interambulacral plate, evidently one belonging to the upper part of the test, differs by its prominent, moderately sized, tubercle, comparatively large areola, surrounded by slightly prominent mammillary granules, alternating with other more strongly marked ones, and by the great size of the other granules, all of which are radiately elongated, from all known species of *Cidaris* of which I have been able to consult descriptions or figures.

Locality.—South-east of Arrialoor, out of a light grey sandstone.

Formation.—Arrialoor group.

Order. **ASTEROIDEA.**

The starfishes differ from the other Echinodermata by the depressed, rounded or pentagonal form of their body, the angles being prolonged into five single or branched arms, on which the ambulacral grooves, originating at the mouth, are continued; they are lined on either edge with one or more series of pedicles which constitute the principal locomotive organs. The mouth lies on the lower side and is central.

The two principal suborders are the *OPHIURIDÆ* and the *ASTERIIDÆ*, which by some authors are regarded as two different orders. Although, on account of the difficulties in preservation, they are not so common in a fossil state as are other Echinodermata, their representatives occur already in silurian rocks, but the larger number of them, both of genera and species, belongs to the present epoch.

We unfortunately do not possess even a fragment of the whole order from the South Indian cretaceous deposits. Prof. Forbes, however, reports upon a fragmentary specimen of an Ophiurid fossil from Verdachellum, out of Mr. Cunliffe's collection. As I am unable to add any information regarding the species, I will, for the sake of completeness, transcribe Prof. Forbes' note.

OPHIURA? CUNLIFFEI,* *Forbes*. Pl. VII, Fig. 40.

"Part of the disc and arms of a very distinct species, apparently belonging to "the typical genus *Ophiura*, and evidently allied to the *Ophiura serrata* of Römer, a "species found in the white chalk of Germany and England. The plates of the disc "in the Indian fossil are larger than in any known species of the genus. The "disc-shields at the bases of the rays are broadly oblong and somewhat triangular. "The scales of the centre of the arms are small and angular; the lateral scales "are very large and oblong. The spines are not preserved, but were probably short "and obtuse. The figure represents the specimen of the natural size. It was "found by Mr. Cunliffe at Verdachellum."

Order. **CRINOIDEA**.

The Echinodermata included in the present division are, as regards external characters, distinguished by a cup-like body, or calyx, which is composed of zones of calcareous plates, and, as a rule, it is dorsally attached by an articulated stem, and on the opposite end provided with articulated arms. The stem is either single, or with lateral appendages, and at the base variously branched, like the roots of a tree; rarely it becomes lost in advanced age, or still more rarely is it altogether wanting, in which case the calyx is either quite free *(Marsupites)*, or directly grown on to foreign substances *(Holopus)*. The plates composing the lower portion of the calyx are not articulated, those of the upper occasionally or partially so; they include the internal organs, and the upper end has a hard or membranaceous cover, usually provided with a single central or eccentric opening, which often serves as oral and anal aperture at the same time. From this aperture generally extend furrows to the arms, continuing on the inner side of these to their different branches; they are lined with cilia, which facilitate the access of water to the mouth. As a rule, there are five arms, or a multiple of the same number, rarely four, and still more rarely a larger or smaller number.

Out of about 136 different genera of Crinoidea, only three—*Pentacrinus*, *Antedon* or *Comatula*, and *Holopus*—occur living, while the greatest number is found fossil, and the majority of them are from palæozoic and mesozoic deposits. Our knowledge of the structure and internal organisation of the whole group has been recently very considerably increased by the valuable researches of Dr. Carpenter and Prof. W. Thomson upon the recent *Antedon (=Comatula)*, and there is little doubt but that more extensive dredging operations will materially add to the information on this interesting branch of zoological science, as we already know from the reports which have reached the public of Prof. Agassiz's expedition in American waters. Count Pourtalés has recently described several interesting species of *Antedon* from the American waters.

Bronn divides the CRINOIDEA into—*1st*, *Cystidea*; *2nd*, *Costata*; and *3rd*, *Brachiata*. The last is the most numerous, and is separated into two natural groups:

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* *Ophicoma Cunliffei* apud d'Orbigny, Prod.

the *Articulata* with the plates on the upper part of the calyx articulated, and the *Tessellata*, in which all the plates composing the calyx are merely in contact with each other, without articulation.

Of the *Articulata*, the only species occurring in the cretaceous rocks of South India is a *Pentacrinus*, a few fragments of a stem having been found in the Arrialoor sandstone near Shillagoody. The short, at the margin distinctly dentated, joints are, at the middle of the periphery, provided with a tuberculated ridge, the tubercles being most conspicuous between the rounded angles of the joints. The facets on the planes are oval, and the grooves and ridges long; the central areolæ narrow, their breadth being equal to one-third of the whole width of one facet. The general character of the stem exactly agrees with that of an unnamed species delineated in figure 11 on plate xix of Dixon's Geol. of Sussex, this specimen with several other similar ones being derived from the white chalk. (Comp. pl. VII, figs. 38—39).

Of the second group, two species appear to be represented, belonging to the remarkable genus *Marsupites*, which, together with *Astylocrinus*, belongs to a special family—the *Marsupitidæ*,—differing from all other known *Tessellata* by the single basal and an entirely free calyx, without a trace of a stem or a special place of attachment.

I. *Genus.*—MARSUPITES, *Mantell*, 1821.

Miller, Crinoidea, p. 134.

Mantell, Foss. Sth. Downs, p. 183.

Calyx cup-shaped, perfectly free, composed of regular series of plates; one basal surrounded by two alternating superposed zones, each of five subradialia, and followed by a series of five radialia, to which five dichotomous arms are attached; ventral portion of calyx apparently covered with scales or small plates, out of which the oral aperture protruded.

The species of this genus are only known from upper cretaceous deposits.

1. Marsupites Milleri, *Mantell.* Pl. VII, Fig. 41.

1822. *M. Milleri*, Mantell, Geol. Sth. Downs, p. 184;—*idem auctorum.*

M. calyce ovate cupuliformi, tabula basali pentagona, subradialibus inferioribus pentagonis, superioribus æqualibus, hexagonis, lateraliter subangustatis; radialibus minoribus, crassis, supra medio articulationibus emarginatis instructis, lateraliter declivibus, ad angulos subsulcatis, sulcis fere ad medium tabularum subradialium prolongatis; tabulis omnibus modice convexiusculis, radiatim granulatis atque ad margines striato sulcatellis.

The basal is perfectly equal in form and size to one of the lower sub-radials, while one of the hexagonal sub-radials is a trifle smaller, and the radials are considerably smaller, but thicker than the others. At the upper end the radials have broad, nearly semi-circular depressions, the external segment being separated by a raised ridge, provided with a hole in the centre, while the inner portion is trilobate;

the total width of the joint cavity for the insertion of the arms is somewhat more than half the total breadth of the upper edge of one radial. At the sides, each of these plates has a broad smoothish or irregularly rugose slope extending towards the margin, and the united depression is continued as a narrowed triangle towards the centre of the respective upper sub-radial, and is margined on the angles by a more or less distinct smooth groove. All the plates are moderately convex, sub-mammillate in the centre, and ornamented with radiately arranged granular tubercles, or they are nearly smooth, merely with an indistinct radiating striation. Sometimes sharpened ridges proceed from the centre to the middle of the margin of each plate, but they appear to be equally often wanting.

Some doubt exists as to these variations referring only to one species of *Marsupites*, or to three, as indicated by Forbes. *M. lævigatus* was proposed by Forbes for fig. 8 of pl. xx of Dixon's Geol. of Sussex. The form of the upper sub-radials in this figure is remarkably regularly hexagonal, and as there is a slight difference in the ornamentation of the plates, it is possible that the species in question is a well founded one. The two other species admitted are *M. ornatus* of Miller and *Milleri* of Mantell. When we compare the original figures of these two forms, the only difference of any value appears to consist in the stronger ribbing of the plates in the former, as compared with the latter. It seems to me very probable that this difference is only an individual one, but unless the authentic original specimens had been examined and properly compared, it would be vain to prove the invalidity of the distinctions between the two species, particularly when we find two forms, such as those indicated, also represented in extra-European cretaceous deposits.

M. Milleri is a common fossil in the Upper Chalk of England, North France, and it also occurs in the beds with *Bel. quadrata* in Western Germany, and in upper cretaceous beds in Poland.

Locality.—Near Arrialoor, in a whitish sandstone.

Formation.—Arrialoor group.

2. MARSUPITES *conf.* ORNATUS, *Miller*. Pl. VII, Figs 42—43.

There are two plates of upper sub-radials evidently belonging to a species which differs from the former in a similar respect, as I have noticed to exist between *ornatus* and *Milleri*. Both of the plates have the centre more distinctly mammillated, the ridges proceeding to the median parts of each side more distinct, and the interspaces between them more coarsely and less regularly granular. They evidently belong to *ornatus*, as presently understood, or else to a very closely allied species.

Locality.—Near Olapaudy, in a yellowish ferruginous sandy rock.

Formation.—Arrialoor group.

GENERAL REMARKS ON THE DISTRIBUTION OF THE ECHINODERMATA IN THE SOUTH INDIAN CRETACEOUS DEPOSITS.

The conclusions which can be drawn from the examination of the Echinodermata coincide well with the results obtained from that of the different classes of Mollusca occurring in the above-mentioned deposits.

Of the five different orders of the class three occur in South India. Our knowledge, however, of the single imperfect specimen of *Ophiura*, described by Forbes, is entirely insufficient, and as the geological position of the species is also not known, the whole of the Asteroidea must be left out from the present consideration regarding the age of the rocks. Of the two other orders the Echinoidea are represented by 38 species, but of these again four remain doubtful as regards their geological age. The *Crinoidea* have only two, or possibly three, species, belonging to *Pentacrinus* and *Marsupites*, the latter being an exclusively cretaceous genus. The local and geological distribution of the different species will be more readily understood from the following list:—

No.	Name.	Page.	Plate.	Figure.	Locality in Southern India.	Geological group in Southern India.	Locality and Geological position in other countries.
	ECHINOIDEA.						
	Fam. SPATANGIDÆ.	9					
I	HEMIASTER—	10					
1	„ *similaris*, Stol. ...	10	I	1	Ootatoor	Ootatoor.	
2	„ *serpenens*, (Forb.)	11	I	2	? Pondicherry	? Valudayur.	
3	„ *tuberosus*, Stol. ...	12	I	3-6	Karap., Mulloor, N. of Alundanap.	Arrialoor, Trichinop. ?	
4	„ *frontacutus*, Stol.	13	I	7-8	Ootatoor	Ootatoor.	
5	„ *vicinus*, Stol. ..	13	II	1	Moraviatoor	Ditto.	
6	„ *inaequalis*, (Forb.)	14	II	2-3	Ootatoor	Ditto.	
7	„ *cuna*, (Forb.) ...	15	II	4-5	Pondicherry	Arrialoor.	
8	„ *indicus*, Stol. ...	16	II III	6-7 1	Mull., Arr., Serdamung. ...	Ditto.	
9	„ *cristatus*, Stol. ...	17	III	2-5	Karap., Mull.	Ditto.	
10	„ *pullus*, Stol. ...	18	II	8-9	Arrialoor	Ditto.	
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We see from this table that, although the majority of the families of the Echinoidea are represented by one or a few species only, the genera are such as are mostly characteristic of the cretaceous formation. The total number of all known Echinodermata is 42, somewhat larger than that of the Brachiopoda and Ciliopoda, but much less than that of the three other classes of the Mollusca. For the reason already stated, five of the species must be omitted from the list upon which any geological conclusions can be based. The remaining thirty-six are seen to be exclusively* restricted to the lowest and the uppermost of the three groups distinguished, the Ootatoor and Arrialoor groups, namely, ten species occurring in the former and twenty-six in the latter group.

Out of the ten species from the Ootatoor group four appear to be identical with European species from Cenomanien beds, but only one of the identifications has been considered as certain, namely, that of *Cidaris hirudo,* while the materials for the recognition of *Cidaris vesiculosa, sub-vesiculosa* and *Faringdonensis* are not sufficient. There can be, however, little doubt that not only these, but also the other species, considered as new, exhibit a markedly close affinity to Upper Greensand forms, and that, therefore, the Cenomanien age of the Ootatoor group is confirmed by the examination of the few Echinoderms known from it.

The twenty species from the Arrialoor group are, with three or possibly four exceptions, peculiar to that group in India. The exceptions refer to *Echinoconus conicus (= Galerites albogalerus), Cidaris sceptrifera, Marsupites Milleri* and possibly *M. ornatus;* all these occur in the Upper Chalk or Senonien beds, thus adding to the former proofs regarding the age of this group, which corresponds to d'Orbigny's Senonien and Danien. Taking now the entire number of Echinodermata from South India, I consider *Echinoconus conicus, Cidaris hirudo, vesiculosa,* and *sceptrifera,* and *Marsupites Milleri,* as sufficiently certainly identical with the same species in Europe, and this would give twelve per cent. which the South Indian upper cretaceous deposits have in common with those of Europe.

---

* *Hemiaster tuberosus* is the only species which occurs in the Arrialoor and possibly in the Trichinopoly group, but the latter is far from certain.

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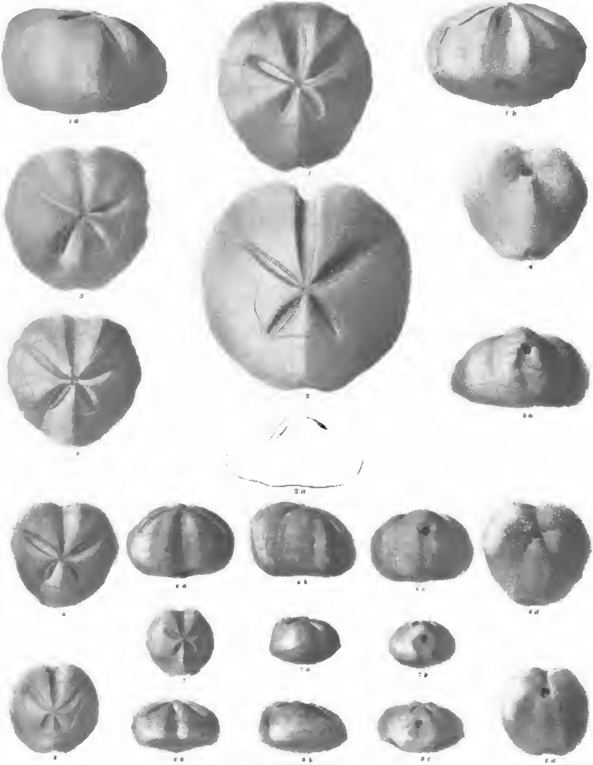

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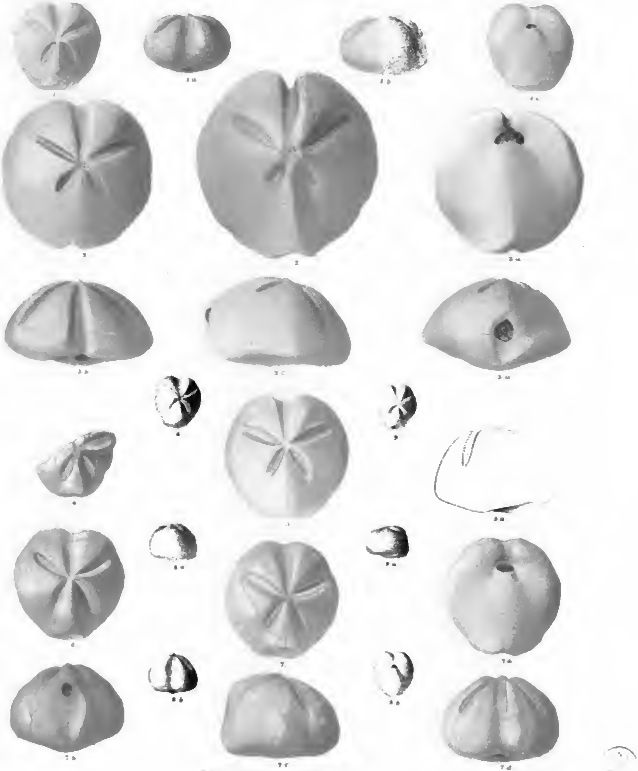

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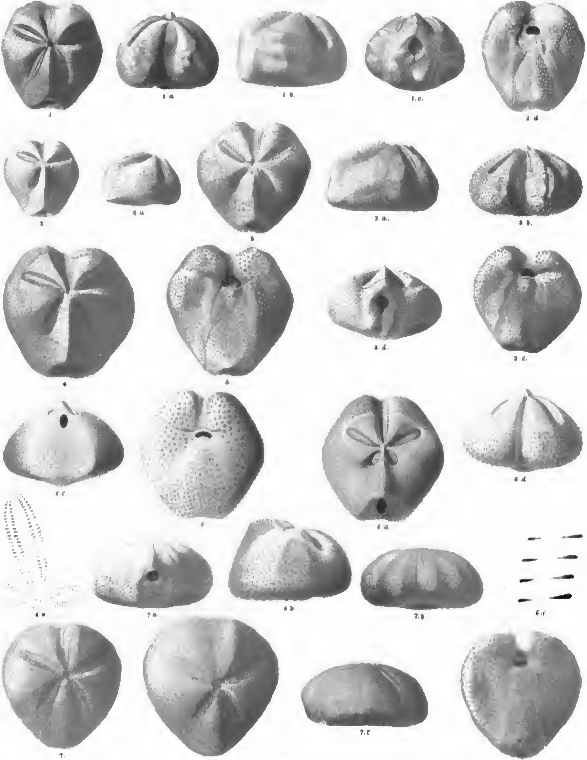

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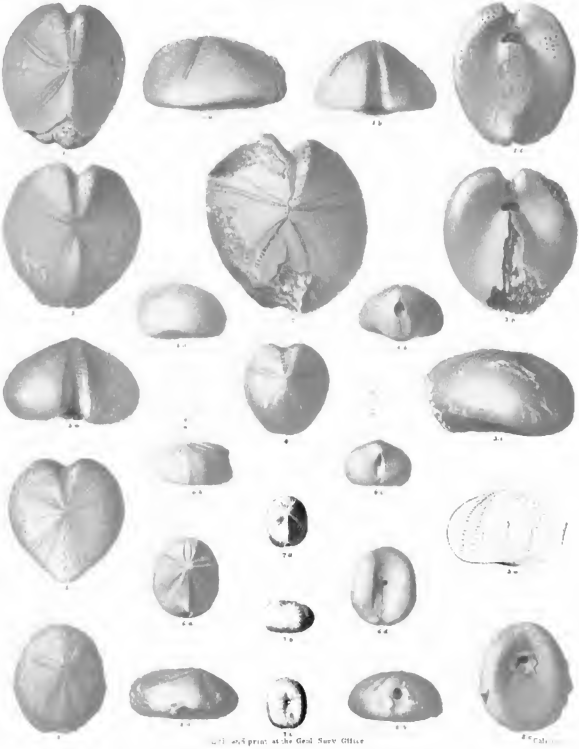

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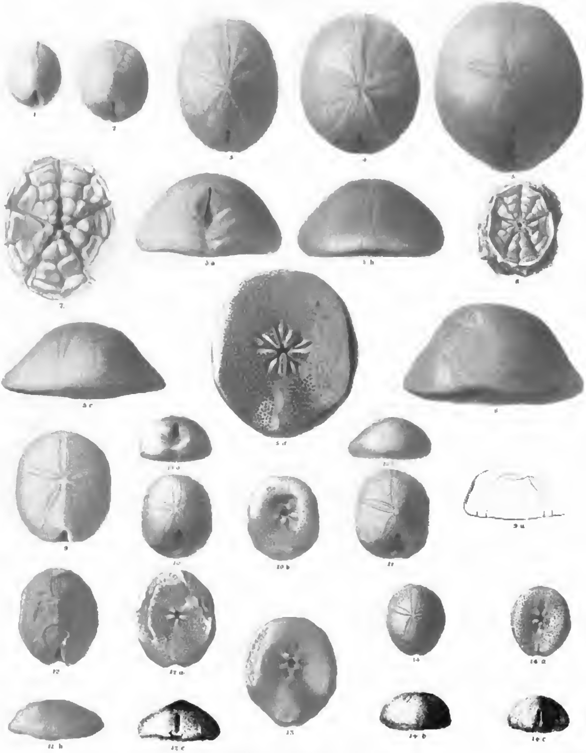

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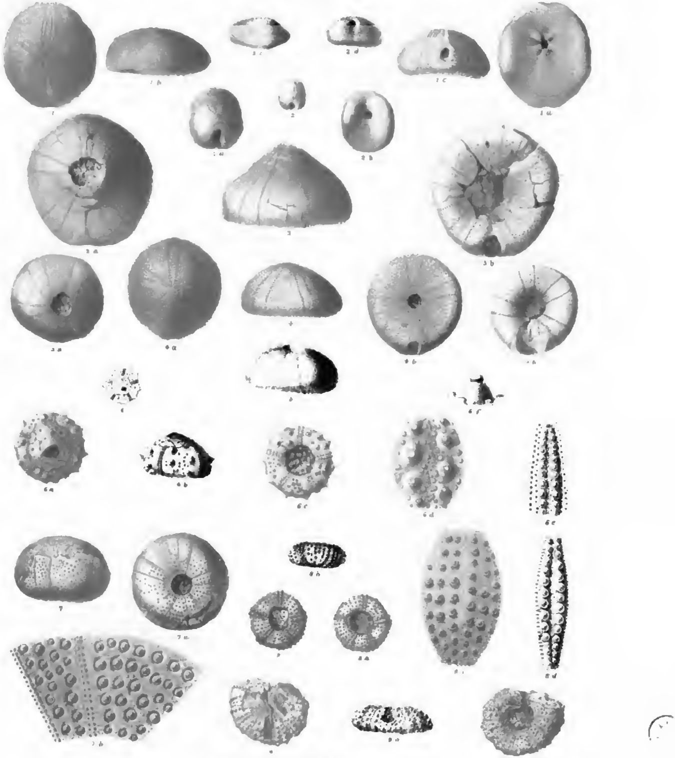

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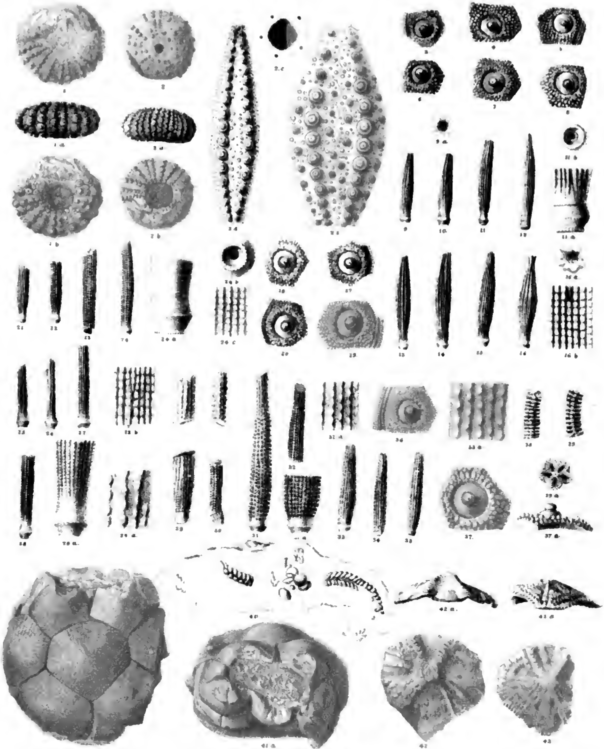

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Vol. IV. 4.

Ser. VIII. 4-5. The CORALS or ANTHOZOA, with notes on the Sponges, Foraminifera, Arthrozoa and Spondylozoa,

by Ferd. STOLICZKA, Ph. D., F. G. S., &c., &c.,
Palæontologist, Geological Survey of India.

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INTRODUCTION.

The second division of the Actinozoa, represented in the cretaceous deposits of the Trichinopoly district in Southern India, comprises the corals,—Anthozoa, or Polypi, as they are often called in zoological manuals. They have yielded 57 species, of which the majority occurs in the lowest beds of the series, the Ootatoor group, while the two higher divisions, the Trichinopoly and Arrialoor groups, are comparatively poor in corals,—just the reverse of what I formerly stated respecting the Gastropoda and Pelecypoda. The number of species which had already been described from European cretaceous deposits is small, but the geological results, in point of comparison of our fauna and its age with that of foreign deposits, is rather an interesting one, as I shall have occasion to notice at the end of the detailed descriptions.

The smaller the animals are, the more steadily and energetically they appear to work, in order that they may replace by numbers what they lose by individual size. Indeed, even setting aside the interest which the study of corals possesses for the morphologist and the systematic zoologist, few other even of the higher classes of the animal kingdom can compete with the importance, which the corals possess, and for ages past have maintained, in the economy of nature. The distribution of the corals in the different depths of the sea has been for years past studied with considerable interest; and the recent researches in deep sea dredgings are adding largely to the information, which is placed at the disposal of the geologist. Need I mention the enormous value which Darwin's and Dana's studies of the formation, extent, and distribution of coral reefs possess for geological research! It is, I believe, justly asserted that more than one-half of our ancient limestone formations is to be attributed to the existence of corals and their colonies forming reefs. What greater help can a surveying geologist find, than is afforded to him by the discovery of an ancient coral reef, or of a reef-limestone! If he had been up to that time in doubt about the stratigraphical series of his beds or formations, he finds himself upon that discovery *quite at home.* He knows where he has to seek for the ancient land; he looks after certain animal forms in the lagoons; after others in and on the coral limestone; and the thickness and character of the cropping out of the limestone indicate to him the relation of the beds beyond the reef.

CORALS OR ANTHOZOA

FROM THE

CRETACEOUS ROCKS OF SOUTH INDIA.

Sub-kingdom, ACTINOZOA.

Class, ANTHOZOA OR CORALS.

CHARACTER.—*Actinozoa consisting of a digestive cavity, provided with a single opening, which is oral, anal, and genital, internally divided at certain regular distances by membranes or laminæ projecting towards a real or imaginary axis, while the upper edge is surrounded by radially disposed, generally hollow, tentacles; male and female generative and secretionary organs situated in the so-called loculi between the membranes or septa; propagation takes place by ova, or by buds, or partial division; special organs of the senses, of respiration, and circulation, and, as a rule, also of locomotion, are absent. All the Anthozoa are in their natural state inhabitants of the sea, or at least of brackish waters.*

The 'Histoire Naturelle des Coralliaires' by **Milne-Edwards** and **Haime**, 'Klassen und Ordnungen des Thierreiches' by **Bronn**, many treatises of Zoology, and recently **Fromentel's** Zoophytes in the Paléontologie française, Vol. VIII, contain such detailed accounts of the history, organisation, geographical and geological distribution, etc., of this class that it would be quite superfluous to repeat the same in this place. It will fully serve our object towards a proper understanding of the descriptive portion of this monograph, and the terminology used therein, if I attempt to give a brief abstract of the general structure of these creatures, followed by a few words on the distribution and classification of the same.

The Anthozoon in its simple form is a more or less round or cylindrical sac, usually sessile by a broad base, on the opposite end provided with a single oral opening, surrounded by tentacles, of which there are four, six, eight, or a multiple of these numbers present. The oral opening passes through an enlargement, formed by an inverted portion of the outer wall of the body, called the stomach, or directly into the large internal cavity of the body, which is divided into compartments (the so-called *loculi)* by the mesenterial laminæ or septa, these being in an equal or smaller number present than the tentacles. The mode of development followed in these organs is of great systematic importance. There appears to be no strict separation between the animals which possess a so-called stomach, and to which the name Anthozoa, Polypi, or Corals, is restricted, and those in which the mouth directly communicates with the general cavity of the body, and which, according to Agassiz, have in late years been transferred to the Hydrozoa,—namely, the so-called Podactinaires or *LUCERNARIIDÆ*, together with the Madreporaria tabulata and rugosa of Milne-Edwards and Haime.

The general cavity of the body is internally in its entire extent instructed with cilia; the chylus is formed in, or passes from, the so-called stomach into it, and its circulation, as well as that of the water for purposes of respiration, is chiefly produced through these cilia, while the tentacles act not only as prehensile organs for obtaining food, but also for producing a current of water leading to and from the mouth. This very simple arrangement dispenses with the necessity of all other special organs or vessels for digestion or respiration. Equally so a nervous system, or special organs of sense, are absent, but the soft parts of the body, and particularly the tentacles, are sensitive both to touch and to the light. Some naturalists believe that the presence of peculiar branched cells in the oral disc indicates the rudiments of a nervous system. In some of the Actiniacea there are peculiar thread-like organs, the so-called craspeda, present between the septa, and these appear to act, at least in some cases, as secretionary organs and assist in digestion. Besides there are in some Anthozoa other organs for the defence of the animals, the so-called nettle threads or acontia, which are emissible and secrete a sharp fluid in the cnidæ or nettle cells.*

The sexes are, as a rule, distinct, either in the same or in different individuums, and in some cases of the compound corals one sex is said to be restricted to a single colony. The progeny leaves the mother either in the form of fertile ova, or as a developed Anthozoon with tentacles. The young, when it leaves the ovum, swims about with a row of cilia, gradually the body curves, forms an internal cavity, the rudiments of tentacles appear, and the young Anthozoon becomes sessile. In other cases propagation takes place by budding, or gemmation, and thus compound colonies are formed.

The body of the Anthozoon is composed of an external and an internal cilia-bearing skin, each consisting of several layers. Between them is the muscular system developed, the several layers being composed of vertical or longitudinal and of concentric fibres. All these soft parts appear to be in certain cases capable of secreting solid particles of various shapes, the so-called sclerites or sclerodermites, which either remain isolated in the fleshy or dermal mass, or they coalesce to a more or less solid, reticulated or porose skeleton, which was called *sclerenchyma* by Messrs. Milne-Edwards and Haime.

The calcification, or rather sclerification, progresses in somewhat different manner in various forms. In some it takes place only at the basis of the single or compound individuum, and continues to grow and branch as a kind of axis, surrounded by the soft or partially hardened parts of the animal. This kind of progress has been called by Dana foot-secretion, and forms the so-called *sclerobasis* of the *Gorgonidæ* or *Antipathidæ*. In the so-called Madreporaria the sclerification takes place in the whole derma, either externally as *exotheca* or internally as *endotheca*, or in the central column, forming the so-called *columella*; all these secretions begin at the base of the individuums and spread gradually upwards, forming a more or less complete cup or *calyx*. The endotheccal system is strengthened by a sclerification of the mesenterial membranes or laminæ, which extend towards the centre of the animal and form the so-called *septa*, while externally these often correspond to or pass into similar elevations, called the *costæ*. The septa are either connected by vertical cross bars at certain regular distances, as in the *Fungidæ*, called *synapticulæ*, or they are connected by more horizontally distributed curved laminæ in irregular manner; these are called *dissepiments*. These, again, are distinguished as *endothecal* or *exothecal dissepiments*, according to whether they become developed between the septa or between the costæ. The columella is either a true one, solid, columnar, fibrose, spongiose, or laminar, or it is a pseudo-columella, merely formed by a twisted prolongation of some septa.

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* Compare my note on *Sagartia* in Journ. A. S. B. for 1869, vol. xxxviii, pt. ii, pp. 43 and 50.

Between the inner terminations of the septa and the columella there are in some forms of corals lamellar or styliform processes developed, which are called *pali*.

Both the septa and pali generally follow certain rules in the course of their development. As already observed, the original number of septa is either six* or eight; these are called the *primaries*, the subsequent the *secondaries*, and so on. Taking six primaries as the most usual number, each of the six original compartments, including all the septa of subsequent orders, is called a *system*, and the row of septa itself a *cycle*. The six primaries are followed by six secondaries, each system being divided by one septum, this being the second cycle. This is followed again by a division of each compartment into two by a septum, there being twelve of them in all, forming the third cycle. Up to this the septa of each cycle are in a regularly formed corallum equal in length and strength. The fourth cycle is formed by twenty-four septa, but they are not equal, because after the third cycle each subsequent order consists merely of twelve septa. Thus we have in the fourth cycle twelve septa of the fourth and the same number of the fifth order. The rule is, that the twelve younger septa appear first next to the oldest septa, and then to the next older, and so on, and that according to their appearance they increase in length and strength. In the same way we get forty-eight septa in the fifth cycle, belonging to the 6th, 7th, 8th, and 9th orders, and so on; the coral would then possess ninety-six septa, of nine different orders, in five cycles and six systems.

The *pali* always appear after the full development of the septa, and, therefore, they are never present opposite the septa of the last, but always the preceding cycles. They are either all equal and form a single row, or *coronet*, or unequal, forming two or more coronets. If only one coronet of pali is present, it exists opposite the septa of the penultimate cycle; if there are two coronets, they are placed opposite the penultimate and antepenultimate cycles, and so on.

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* According to Ludwig, the Rugosa also have originally six primary septa, but two of them become obsolete, the further development becoming, therefore, asymmetrical.

The septa are on the upper edges either entire, or granular, serrated or dentate; laterally they are granular or spinulose. They are, however, not in all cases regularly developed. Sometimes one or the other of the primaries become obsolete or smaller; in other cases two or four of the secondaries become equal to the primaries; and in such cases we have apparently 3, 4, 5, 8 or 10 systems instead of six.

All these characters referring to the sclerodcrma,—the presence or absence of an exotheca, of dissepiments or synapticulæ, or of pali, the number of systems, cycles and orders of septa, and whether their upper edge is entire or not, etc.,—are of the greatest systematic importance.

In the compound coralla the single individuums are more or less closely connected with each other by the cœnenchyma, which is solid or porose, cellular or lamellar. Its development depends upon the manner of more or less perfect gemmation of the coralla.

I have already observed that all the Anthozoa are inhabitants of sea or brackish water. They are distributed in all latitudes, but, as usually, are more numerous in tropical than in cold seas; the reef-building corals are restricted to the former seas.

Comparatively only a small number of species, mostly the single coralla, live in great depths of the sea; as a rule, they do not extend beyond about 20 fathoms, and generally they prosper best where the water is clearest and most agitated by atmospheric influence. On the large reefs only the upper layers to the extent of one or two feet are occupied by living individuums. For the study of the character and extent of the various coral reefs and their importance to the geologist, I must refer the reader to the works of Darwin and Dana. It is sufficient to say that the knowledge of the fossil coral fauna is no less important for the determination of the age of geological strata than that of any other group of animals. The simple fact that whole genera and families of corals have become almost entirely extinct indicates the necessity of their fossil remains for the systematic zoologist.

The classification of the Anthozoa is by no means so easy as their simple organisation might indicate, and there is considerable disagreement between various authors even as regards the first principles which ought to be adopted. For our purpose, it will, I think, be sufficient if I give a sketch of the first few divisions according to Bronn, his arrangement being only slightly modified from that of Messrs. Milne-Edwards and Haime.

Bronn, paying more regard to the mode of multiplication than to the number of tentacles and loculi, divides the Anthozoa into—

I.—POLYCYCLIA, with six primary tentacles and loculi, both increasing in number with age, forming two or more cycles.

II.—MONOCYCLIA,[*] with six or generally eight tentacles or loculi, not increasing with age.

The former order very closely corresponds to the ZOANTHARIA of authors, and the latter to that of the so-called ALCYONARIA, adding to them the *ANTIPATHIDÆ* with six tentacles, as showing in many respects close relations to the *GORGONIDÆ* with eight tentacles.

The first order, to which the subsequent remarks will solely apply, is divided into—

I.—*SCLERODERMATA* or *MADREPORARIA*, with the sclerenchyma forming a more or less solid, complete skeleton, and

II.—*MALACODERMATA*, with or without[†] single loose sclerites in the derma.

The Madreporaria are generally divided into five sub-orders:

1. *M. APOROSA*, with the septa well developed, and the whole sclerenchyma solid, not perforated.

2. *M. PERFORATA*, with septa well developed and the sclerenchyma perforated.

3. *M. TUBULOSA*, with the septa rudimentary.

4. *M. TABULATA*, septa well developed or rudimentary, chambers divided by horizontal laminæ.

5. *M. RUGOSA*, with only four primary septa and systems developed in the full grown coral; septa never porose and not granulated laterally.

The *TABULATA* are now generally referred to the Hydrozoa, but I have already observed that the researches in this respect do not appear to me conclusive. The same has been predicted of the *RUGOSA;* by some authors their transfer into the Hydrozoa has actually been carried out, and now it has been shown that there is still less reason for this somewhat hasty alteration of our systematic arrangement.

In the South Indian cretaceous deposits we have fifty-three species belonging to the *M. APOROSA*, three belonging to the *M. PERFORATA*, and one to the *M. TABULATA*. Their distribution in the different families will be readily seen from the table at the concluding pages of this Monograph.

MADREPORARIA APOROSA.

Family,—CARYOPHYLLIDÆ.

These include a number of genera with simple coralla, attached by a narrow base, or free, with round or ovate calyces divided by septa, with one or more rows of pali round a real or imaginary columella, and with the chambers open in the entire height of the corallum.

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[*] His *DYCYCLIA* or the *LUCERNARIIDÆ* are, I think, rightly excluded from the Anthozoa.

[†] I am by no means certain that it is correct to speak of the total absence of sclerites or solid inorganic bodies in the *Actiniaceæ*, as is generally done even in the most recent works on zoology. In my paper on the anatomy of *Sagartia Schilleriana*, I have, I believe, satisfactorily shown not only the presence of loose scleroid particles in the internal tissue, but of an almost regular network of the same. (Comp. Journ. A. S. B., 1869, vol. xxxviii, pl. iv, p. 38). I do not consider it at all improbable that the presence of sclerites will be proved also in other similar species. The plan which I would recommend for this purpose is to kill the animal gradually by adding fresh to sea water; then place the specimen in a platina crucible and heat it, until all organic matter is burnt off. In this manner I obtained the rudiment of an almost regular skeleton in the above-mentioned *Sagartia*.

The *Caryophyllidæ*, which were by Milne-Edwards and Haime considered as a sub-family of the *Turbinolidæ*, differ from the latter by the presence of pali. Fromentel (Pal. Franç. terr. cret., vol. viii, 1863, p. 163,) distinguishes fifteen genera, and indicates two more; but three of these genera occur in South India. *Caryophyllia* with four, *Trochocyathus* and *Platycyathus* each with a single species. The first genus belongs to the group with only a single row of pali; the two others have a double row of unequal but simple pali.

I. *Genus.*—CARYOPHYLLIA, *Lamarck*, 1801.

Comp. Duncan, Palæont. Soc., vol. xxii, Suppl. to Cret. Corals, pt. II, No. 1, p. 2; Fromentel, Paléont. Franç. terr. cret., vol. viii, 1863, p. 164.

The *Caryophylliæ* have a simple corallum, which is adherent by its base to foreign masses; the calyx is circular or somewhat ovate, generally rather concave; the columella composed of twisted and more or less confluent lamellæ, forming a crispate, convex upper end; the pali are well developed, all of the same form and size; septa straight, rather broad, sometimes slightly thickened towards the inner end, generally arranged in six, very rarely in only five,* systems, which are occasionally somewhat irregularly developed; costæ numerous, sub-equal, straight, more or less finely granular, generally most distinct near the calyx, and becoming less distinct towards the base.

Stokes in 1828 was the first to define the present genus in the sense in which it is at present accepted in science. D'Orbigny called a few fossil species *Amblocyathus*, while others he referred to *Cyathina*. This last name has also been accepted for the cretaceous species by Messrs. Milne-Edwards and Haime in their monograph of the British cretaceous species, but in their Hist. Nat. d. Corall. the propriety of the name *Caryophyllia* was re-established. Fromentel (l. cit.) unites to the present genus also *Bathycyathus*, Milne-Edwards and Haime, which he says only differs from typical *Caryophylliæ* by thinner pali, more closely united to the septa.

The species of *Caryophyllia* occur both fossil and recent, but the occurrence of the genus in rocks older than cretaceous is not sufficiently certain.

There are four species of the genus represented in the South Indian cretaceous deposits; all belong to the group with the septa arranged in six systems, and all appear to be as yet undescribed forms.

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* *C. decemplex*, Fromentel, Pal. Franç. terr. cret., vol. viii, p. 168.

1. Caryophyllia Arcotensis, *Stoliczka*. Pl. 1, Figs. 1—10.

?? *Turbinolia Arcotensis*, Forbes, from Pondicherry.

Caryoph. corallum inverse conicum, modice elatum, per-variabile, frequentissime paulo curvatum et ad intervalla irregulariter contractum, basi angustissima affixum; superficie sublævi, prope calycem costulata, costulis sub-æqualibus, obsolete rugulatis vel ommino lævigatis; calyce circulari seu fere circulari, medio profunde excavato; septis in quatuor cyclis sæpissime perfectis dispositis, lateraliter confertim granulatis, ad marginem calycis convexe elevatis: primariis fortissimis, secundariis paululum brevioribus atque tenuioribus, terminationibus conspicuiter incrassatis; palis duodecim brevibus, modice incrassatis atque exsertis, ad terminationes septorum ad cyclum tertium pertinentium sitis; columella breviter libera, convexa, rugosa, foliose torta, circiter quintam partem calycis diametri crassa.

This is an extremely variable species, reversely conical, and always possessing a very narrow basis, sometimes with a slightly dilated disc by which the specimens were sessile. The corals have generally a height of about 17 mm., and the calyx a diameter of 9 or 10 mm. Specimens of 20 mm., or a greater height, are very rarely met with, and equally rare are those with a very wide calyx, such as the specimen represented in fig. 6 on pl. I. The mural theca is well developed, rather thinning out towards the edge of the calyx. The surface shows at distances irregular rugosities and contractions, on which the costæ are sometimes obsoletely traceable; but they scarcely ever reach as far as the base, and the lower part of the polypid is usually quite smooth, while near the upper edge the costæ are always distinct. They are sub-equal in strength, smooth, or very finely and distinctly rugose. The calyx is circular or very nearly so, deeply excavated in the centre; the columella, convex, rugose, and composed of twisted papillæ. There are nearly invariably four complete cycles of septa present, arranged in six systems. The pali are of moderate length and strength, twelve in number, one being opposite to each tertial septum (see fig. 3*a*). They are slightly raised, and in the lower section of the corallum become, therefore, confluent with the adjoining septa (see fig. 10*a*). The columella is very nearly one-fifth of the entire width of the calyx.

Locality.—East of Andoor, in a pale coloured, moderately coarse sandstone; common.

Formation.—Arrialoor group.

I have selected for the above species the same specific term under which Prof. Forbes described a South Indian fossil as—

TURBINOLIA ARCOTENSIS, see Pl. I, Figs. 11—12.

1846. Trans. Geol. Soc., London, vii, p. 163, pl. xix, figs. 9 *a* and *b*.

Forbes account is as follows:

'*T. testa cylindrica, conica, elongatâ, disco excavato, lamellis* (30) *fortibus* '*radiato; lateribus undulatis, striatis, striis tenuibus, confertis, regularibus, æqualibus.*'

'Diameter of disc $0\frac{6}{10}$ inch. Entire length (or height) $1\frac{6}{10}$ inch.'

'A conical species, usually slightly bent, with finely and regularly striated sides, 'and a star of many strong prominent lamellæ. The specimens are rarely well preserved. The species is gregarious. It approaches nearly several cretaceous and 'also some tertiary forms.'

'*Locality.*—Pondicherry.'

It is impossible to identify the species from such an imperfect description, and the two figures, of which copies are given, do not assist in the determination. Still, it is by no means improbable that Prof. Forbes had specimens of the abovenamed *Caryophyllia* before him. A careful comparison of the type is necessary. I was unfortunately not able to lay hands upon it when examining Forbes' originals in 1867.

D'Orbigny referred Forbes' species to *Ellipsosmilia*, (Prod. II, p. 276), and Milne-Edwards and Haime to *Trochosmilia*, (Hist. Nat. des Corall., II, p. 162); but I do not think that either Forbes' description or figure give any positive indication for the latter generic determination. Indeed, Forbes' figure 9 *b* appears to me to indicate the presence of a columella as well as of pali.

2. CARYOPHYLLIA CUPULIFORMIS, *Stoliczka*. Pl. I, Figs. 13—15.

Caryoph. corallum cupuliforme, basi angusta affixum; costis inæqualibus, fortioribus fere prope basin, alteris ad medium, ceteris in parte superiore, orientibus, omninis granis rotundatis ornatis; calyce late rotundato, modice concavo, ad marginem subacuto; septis tenuibus, in quinque cyclis dispositis, primis quatuor perfectis, quinto imperfecto; palis decem ad duodecim elongatis, crassiusculis, ad terminationes septorum ad tertium cyclum pertinentium sitis, uno vel duobus palis nonnunquam abortis; columella lamellis crispatis, tortis, supra paulo elevatis, tenuibus composita, circiter sextam partem calycis diametri æquante.

A cup-shaped corallum, generally about 12 mm. high, and with the calyx 10 to 12 mm. in diameter, affixed by a very narrow flat base, which easily wears off, and then the specimens appear to be free grown. The surface is unequally costate, almost in its entire length. The twenty-four costæ, corresponding to the three first cycles, originate very near the base and are of about equal strength; those of the fourth cycle begin in the middle, and the last nearer to the edge of the calyx; they gradually decrease in strength, but all are ornamented with densely set small, round, granules. The calyx is round, wide, and moderately concave; the calicular margin rather sharp. There are four perfect, and a fifth generally imperfect cycle, the total number of septa being 70 to 82; all are thin. The pali are moderately elongated and thick; there are usually twelve of them, but sometimes two are displaced or not perfectly developed. The columella consists of very thin and much twisted and contorted lamellæ; its upper surface is very slightly raised and spinulose, and its width is about one-sixth of that of the calyx.

This is a very well marked and easily distinguishable species, both by its short cup-shaped form, with rather strongly and unequally costate surface, and by the large number of thin laterally only very finely spinulated septa.

Locality.—Near Moraviatoor, in a yellowish calcareous sandstone; three specimens have been examined.

Formation.—Ootatoor group.

3. CARYOPHYLLIA GRANULIFERA, *Stoliczka.* Pl. I, Figs. 16—17.

Caryoph. corallum sub-cylindraceo obconicum, breve, basi angustata atque contracta, paulum curvata, affixum, fere omnino costatum, costis sub-æqualibus, dense granulatis; calyce circulari, parum excavato; septis tenuissimis in quatuor cyclis perfectis dispositis, lateraliter minute granulatis; palis duodecim elongatis, paulo incrassatis, breviter elevatis, ad terminationes septorum ad tertium cyclum pertinentium sitis, atque cum iis fere confluentibus; columella circa quintam partem calycis diametri occupante, lamellis tenuibus tortis composita, paululum elevata.

Corallum short, sub-cylindrical, reversely conical, the base being rapidly contracted and slightly curved, the only perfect specimen having been sessile on a small Pelecypod. The mural theca is very thin, and the entire surface covered by densely granulated costæ, slightly varying in strength, and nearly quite straight. The calyx is circular, exceeding the height of the corallum by one or two millimeters, the total height being 9 or 10 mm. In one of the specimens, with a perfect outer surface, the calyx was slightly concave, but it was so obliterated with adherent rock that a section had to be cut, in order to see the distribution of the septa. The only other specimen is a cast. In both the septa are very thin, slightly undulating, arranged in four complete cycles and six regular systems. The pali are elongated, slightly thicker than the primary septa, twelve in number, one palus being opposite each tertial septum. The columella is rather broad and composed of very thin twisted lamellæ; its width equals about one-fifth of the diameter of the calyx.

This is a very beautiful species, resembling the tertiary Australian *C. viola*, Duncan and Wood, (Quart. Journ., Geol. Soc., London, vol. xxvi, 1870, p. 293, pl. xix, fig. 1). Like this species it is remarkable by the almost entire absence of an epitheca; the costæ, corresponding to the first three cycles, originate almost immediately above the base, but the granulation becomes gradually stronger towards the upper edge of the corallum. In both specimens the four cycles of septa are perfect and very regular, but the pali are only slightly prominent and almost join the tertial septa. The granules on the costæ are all rounded. In a section some distance below the calyx the two adjoining pali appear almost to unite and meet with the secondary and tertiary septa.

Localities.—North-east of Odium; a single cast specimen in a whitish shell-limestone; east of Kauray, also a single specimen in a sandy limestone.

Formation.—Ootatoor group.

4. CARYOPHYLLIA GRACILIS, *Stoliczka*. Pl. I, Fig. 18.

Caryoph. corallum sub-cylindricum, curvatum, basin versus compressiusculum atque basi compressa ramose dilatata affixum, theca murali tenuissima; superficie omnino costata, costis subæqualibus, rectis, latiusculis, modice elevatis, minutissime granulate rugulosis; calyce fere circulari, paululum excavato; septis tenuissimis, paulo undulatis atque lateraliter spinulis acutiusculis numerosis instructis, in quatuor cyclis perfectis dispositis, palis duodecim, elongatis, tenuibus, ad terminationes septorum ad tertium cyclum pertinentium ac brevium sitis; columella lamellis tenuissimis, tortis et spinulosis composita, circ. quartam partem calycis diametri æquante.

This species is readily recognised from the other sub-cylindrical forms, like *C. Bredai* or *C. Debeyana*, by the peculiarly compressed and ramose base, by the external surface being entirely costated, by the very thin, spinulose septa, and the rather elongated and slightly thickened pali. This last character shows that the species belong to a group of *Caryophylliæ*, which Milne-Edwards and Haime separated under the name of *Bathycyathus*, and which Fromentel, I think, rightly unites with the present genus.

Locality.—Ootatoor; a single specimen occurred in a light coloured limestone; the calyx has been so much obliterated by adherent rock that it had to be filed off, in order to permit a clear view of the disposition of the septa.

Formation.—Ootatoor group.

II. *Genus.*—TROCHOCYATHUS, *Milne-Edwards* and *Haime*, 1848.

The corallum is cupuliform, or more or less cylindrically elongated and conoid, sessile by a dilated or pedunculate base, but generally becoming free in the adult stage; mural theca well developed in the entire length of the corallum, costæ granular or sometimes spinulose; calyx moderately concave; septa in six systems, and four to six cycles, above sharp, laterally striated, and granulated; pali numerous, unequal in length; columella well developed, broad, composed of twisted strings or columns, or contorted laminæ, granular and generally convex at the upper end.

Milne-Edwards and Haime united d'Orbigny's *Aplocyathus* with the present genus, and Fromentel (l. c., p. 174,) states that *Paracyathus* is not separable from the same, as it only differs by a somewhat large base and a few minor points in the structure of the pali and the columella.

The *Trochocyathi* are found from the middle jurassic period up to the present time; they appear to have been most numerous, however, in the tertiary period. All the cretaceous species, seven or eight, as yet known, have their costæ granulated, not spinose.

Only a single species of the genus has been met with in the Ootatoor beds of Southern India.

TROCHOCYATHUS AFFINIS, *Stoliczka*. Pl. I, Fig. 19.

Trochocy. corallum cupuliforme, latius quam altum, basi obtuse conoideum, liberum, superficie costatum, costis inæqualibus, granulatim rugulosis; septis supra acutiusculis, in quinque cyclis—quatuor perfectis, quinto imperfecto—dispositis, lateraliter granulatis; palis circiter 32, valde inæqualibus, nonnunquam subrectis atque inæqualiter incrassatis; columella lata, lamellis sex, contortis atque confluentibus composita.

A small cupuliform species, very closely allied to *Troch. Harveyanus*, Milne-Edwards and Haime, from the English Gault, but differing from it by a fifth imperfect cycle of septa, and by thinner, more irregular and more numerous pali. The costæ corresponding to the first three cycles and half of the fourth cycle differ very little in thickness, but the remaining are very much thinner; all are very finely and somewhat irregularly granulated. The mural theca is somewhat thickened at the base, but there is no place of attachment traceable on the latter.

Locality.—West of Kurribiem, in a yellowish calcareous sandstone; a single specimen was met with.

Formation.—Trichinopoly group.

III. *Genus.*—PLATYCYATHUS, *Fromentel*, 1861.

Pal. Franç. terr. cret., 1863, tome viii, p. 180.

Corallum discoid or sub-discoid, with the mural theca only horizontally or basally developed and generally smooth; septa numerous, laterally, sharply granulated, arranged in six systems; pali numerous, unequal; columella large, composed of numerous twisted sub-cylindrical columns.

This genus was proposed by Fromentel for Milne-Edwards and Haime's *Trochocyathus Terquemi*, differing from the true *Trochocyathi* by the mere horizontal or basal development of the mural theca, while higher up the septa remain freely exposed. Although this difference appears to be only a slight one, Fromentel believes it to be in conformity with the generally adopted classification, upon which *Leptocyathus*, *Discotrochus*, and other genera are based. There have for the present only two species been described under the genus *Pl. Terquemi* and *Pl. Orbignyi*, both from the cretaceous rocks of France. A third species has occurred in the Ootatoor (Cenomanien) deposits of the Trichinopoly district of Southern India.

PLATYCYATHUS INDICUS, *Stoliczka*. Pl. I, Fig. 20.

Platyc. corallum conoideo sub-discoideum, basi angustatum, medio paulo excavatum, theca murali tenuissima sub-lævigata instructum; calyce lato, modice excavato, septis elevatis in quinque cyclis perfectis dispositis, extus omninis fere æqualiter incrassatis, dense sed minute granulatis, lateraliter costulis interruptis, divaricatis et spinulis interpositis instructis, septis primariis et secundariis fere æqualibus, crassissimis, tertiariis paulo tenuioribus, cæteris tenuissimis; palis 24 elongatis, inæqualibus, tenuibus; columella circiter quartam partem latitudinis calycis æquante, in superficie granulosa.

This species has in general aspect a considerable resemblence to *Pl. Terquemi*, but is readily distinguished from it by the presence of five complete cycles of septa, these being arranged in six systems. The form of the corallum is generally discoid, somewhat roundly angular at the periphery and narrowed at the base, on which alone the mural theca is developed; this last appears to have been nearly smooth. Round the periphery the septa are almost throughout equally thickened and finely granulated, but in the moderately concave calyx those of the fourth and fifth cycle are very much thinner than those of the three former cycles; all are densely spinulose and costulate laterally. The pali appear to be only 24 in number, placed opposite the septa of the fourth cycle, and are unequal. In some cases there appear to be also short pali present opposite the tertials, but they are not well traceable in the only specimen examined. The columella is rather coarsely granular and very slightly convex.

Locality.—North by east of Odium, in a greenish-grey, slightly calcareous sandstone, a single specimen occurred.

Formation.—Ootatoor group.

Family,—TROCHOSMILIDÆ.

(As restricted by Fromentel.)

The coralla are simple, generally sessile by a broad or narrow base, sometimes covered with an epitheca, but generally costate on the surface; calyx round or ovate, concave; septa lamellar, entire on the upper edge, connected by numerous dissepiments, often forming a well developed cœnenchyma.

The TROCHOSMILIDÆ, as defined by **Fromentel**, form a natural group of simple coralla, with entire edges to the septa. The simple growth with the great development of the septa separates them from the STYLINIDÆ and allied families, and the presence of dissepiments from the TURBINOLIDÆ and CARYOPHYLLIDÆ.

Species of the family are probably more numerous in the cretaceous than in any other formation. Only a comparatively small number is found recent. In Southern India we have four genera represented; *Trochosmilia* with four, *Lophosmilia*, *Epismilia*, and *Psammosmilia*, each with one species. Of the first-named genus two species are identical with European ones, *T. inflexa*, **Reuss**, from the Turon beds of the Gosau (Lower Austria) and of France, and *T. tuba*, **Fromentel**, from the beds of the same age at Sougraigne in France.

IV. *Genus.*—TROCHOSMILIA, *Milne-Edwards* and *Haime*, 1848.

Comp. Fromentel, Pal. Franç. terr. cret., tome viii, p. 253.

Corallum simple, obversely conoid, sub-cylindrical or compressed, sub-pedicellate, or sessile with a broad base; calyx sometimes round, more commonly elliptical, very slightly concave; septa numerous in six systems, dissepiments abundant; no columella; wall naked or with a partial rudimentary epitheca; costæ simple, generally granulated and distinct in the entire length of the corallum.

This genus includes a large number of fossil species from cretaceous and tertiary deposits. Four species are found in the cretaceous beds of South India.

Dr. **Duncan**, in his supplement to the British Fossil Corals (Palæontograph. Soc., vol. xxii, p. 5,) regards *Cœlosmilia* as a sub-genus of *Trochosmilia*, the former differing from the latter only by the very small portion of an endotheca and scarce dissepiments. Still it cannot be denied that the *Cœlosmiliæ* form a natural group, and the genus is retained as distinct by most authors who have written on fossil and recent Corals. Indeed in general character the *Cœlosmiliæ* much more resemble the TURBINOLIDÆ than the TROCHOSMILIDÆ.

1. TROCHOSMILIA BREVICULA, *Stoliczka*. Pl. I, Fig. 21.

Troch. corallum breviter cylindraceum, basi latissima affixum, theca murali tenui tectum, costis acutis, granulatis, crassioribus cum tenuioribus alternantibus; sectione rotunda; spatio columellari centrali, minimo; septis in quinque cyclis perfectis dispositis, primariis ad terminationes internas paulo incrassatis.

A remarkably short, cylindrical species, sessile by a very broad base; the mural theca is thin, and the costæ rather sharp, granulated, stronger and thinner ones alternating with each other; in some places three unequal ones, of which the median is the thickest, appear to be situated between two somewhat stronger ones. The calyx was very shallow, almost flat, with slightly projecting septa near the margin; it had to be filed off, in order to show clearly the distribution of the septa.

These are arranged in five complete cycles, those of the first cycle being conspicuously stronger than any of the rest, somewhat thickened at their inner ends; in the two next cycles the septa are equal and only a little shorter than the primaries, while the following orders gradually decrease in size and strength.

Locality.—East of Parally, in a sandy limestone, a single specimen was found.

Formation.—Ootatoor group.

2. TROCHOSMILIA CAMURA, *Stoliczka*. Pl. I, Fig. 22.

Troch. corallum modice elevatum, sub-cylindraceum, ad intervalla irregulariter contractum, basi lateraliter curvata paulumque angustata affixum; costis sub-distantibus, acutis, granulatis, fortioribus atque tenuioribus alternantibus; sectione rotundate elliptica, spatio columellari sub-angusto, circiter tertiam partem diametri longioris æquante; septis in quatuor cyclis dispositis, primariis atque secundariis ad terminationes internas incrassatis.

Although of a similar type to the previous species, in being sessile by a rather broad base, the shape of the corallum is distinctly elliptical in the present form, and the septa are differently arranged, meeting with their ends along a considerably extended columellar space. The septa themselves are also more irregularly undulating, and those of the three first orders are sub-equal in length and strength, conspicuously thickened at their inner ends.

Locality.—East of Parally, in a sandy limestone, only two specimens were found.

Formation.—Ootatoor group.

A third specimen was found a little more south from the above-named locality, north of Moraviatoor. It is a very imperfect one, (Comp. fig. 23, on pl. I); the corallum is very short and rapidly increased in diameter; the base appears to have been very broad, but, like the upper part, it was not perfect, and both have been filed off in order to show the disposition of the septa. The lower section is nearly circular, showing, however, a somewhat irregular increase of corallum; originally it had only four complete cycles of septa very similar in form and distribution to those of *T. camura*. The upper section is roundly ovate, and shows five complete and a sixth incomplete cycle of septa, those of the three first cycles all ending at the edge of the columellar space with a slightly thickened knob. The costæ are apparently alternately thicker and thinner, but are on no part of the theca well preserved. Judging from the majority of the characters alluded to, I much rather suspect that the present fragmentary specimen represents a large and somewhat straight growing corallum of *T. camura* than that it belongs to a distinct species. When better specimens have been found, it will have to be ascertained by observation whether the apparently cuneiform shape of the specimen is sufficiently constant to necessitate a separate designation from the one above noticed.

3. TROCHOSMILIA INFLEXA, *Reuss.* Pl. II, Figs. 1—4.

1854. *Trochosmilia inflexa*, Reuss, Denk. Akad., Wien, Math. Nat-wiss. Klasse, vii, p. 86, pl. v, figs. 3—5.
1867. „ „ apud Fromentel, Pal. Franç. terr. cret., viii, p. 270, pl. 39, fig. 1.

Troch. corallum conoideum, basi attenuatum, arcuatum atque affixum, modice compressum ; theca murali crassiuscula, costis acutis, granulatis, tribus inæqualiter (mediano duobus alteris fortiori) tenuioribus inter duos fortiores sitis, omnibus in parte supera distinctioribus, ad basin nonnunquam fere obsoletis ; spatio columellari angustissimo, longo, septis in quinque cyclis perfectis dispositis, (nonnunquam cyclo sexto imperfecto), iis ad cyclum primum, secundum atque tertium pertinentibus fortissimis, ad terminationes internas incrassatis ac truncatis, oppositis sæpe fere contiguis.

The corallum is generally of a tolerably large size, compressly conoid, with an attenuated and curved basal portion, and a comparatively small place for attachment. The surface is covered by continuous, rather sharp and granular costæ, of which three unequally thinner ones are placed between two stronger ones. The same is the case with the septa, of which there are, as a rule, five cycles, but often in large specimens there is a sixth incomplete cycle present. The length of the columellar space varies; in rounder specimens it amounts to only about two-fifths of the longer diameter; in more compressed ones, it is sometimes nearly one-half of it. The septa of the three first cycles are almost equal in strength, and their ends at the edge of the columellar space are thickened and truncated, often nearly touching each other.

The largest specimen in our collection measures about 80 mm. in height, though the base is not perfect, (about 12 mm. of the original length having been broken away); the larger diameter at the lower end is about 40, and near the calyx, which is somewhat irregularly compressed, about 70 mm. The variations in the compression of the corallum and the number of septa are indicated by the sections represented in figs. 1*b*, 2 and 3.

Localities.—Near Koloture, in an impure sandy, yellowish limestone; near Andoor and north of Alundanapooram, in a coarse conglomeratic sandstone; not common; at the two last named localities mostly rolled fragments were found.

Formation.—Trichinopoly group.

The species was first described by Prof. Reuss from the Gosau deposits in the Austrian Alps, and has since also been found in the Turonien beds near Trets (Bouches du-Rhône).

Its geological position in India exactly corresponds with that in Europe.

4. Trochosmilia tuba, *Fromentel*. Pl. I, Figs. 24—28.

1863. *Trochosmilia tuba*, Fromentel, Pal. Franç. terr. cret., viii, p. 280, pl. 30, fig. 3.

Troch. corallum sub-cylindricum, basi attenuatum, pedicellatum atque lateraliter plus minusve fortiter arcuatum; costis numerosis, æqualibus, granulatis, sulcis angustioribus separatis; calyce rotundato vel rotundate elliptico, modice concavo, septis in quinque cyclis dispositis, lateraliter confertim granulatis; spatio columellari paulum elongato.

This species is rather variable in form; although always approaching the cylindrical shape, its section often passes from round in the young to roundly ovate in the more adult, but other specimens remain permanently cylindrical. The base is considerably attenuated, pedicellate, and curved towards one side. The costæ are all equal in strength, simple in their entire length and granular, the granules being generally better traceable on one than on the other side of each rib. The calyx is moderately concave; the septa arranged in five cycles and six systems, the stronger being well marked in the calyx, and all are densely and rather sharply granular at the sides. The size of the coralla vary from 20—40 mm. in height, and 15 to 25 mm. in the width of the calyx.

Although none of the Indian specimens appear to attain the large size of the type figured by Fromentel, and although the pedicellate base is in none of them very much curved and prolonged, the form of most of the coralla, the equally thick and granular costæ, and the distribution of the septa, leave scarcely a doubt regarding the identity of the Indian with the European fossil.

Locality.—East of Parally, in a sandy limestone; not uncommon.

Formation.—Ootatoor group.

Fromentel described the species from the Turon beds at Sougraigne (Aude), where it was found by Dumortier.

V. *Genus.*—LOPHOSMILIA, *Milne-Edwards* and *Haime*, 1848.

Corallum sub-cylindrical or conoid, sessile, somewhat wider near the calyx; septa exsert, unequal, arched above, laterally granular; columella solid, lamellar, generally short; costæ simple, sub-equal, granular, generally most distinct near the calyx.

This genus was established for a recent species, *L. rotundifolia*, and for one from cretaceous strata, *L. cenomana*, Michelin. The two differ from each other by the former having a tri-lobate columella, while the same is entire in the cretaceous fossil. For this reason *L. cenomana* was separated by d'Orbigny under the name of *Actinosmilia*, a distinction which is believed, and I think rightly, to be unnecessary by the authors of the Histoire Nat. des Coralliaires, (comp. vol. ii, p. 180). Fromentel (Pal. Franç. terr. cret., 1863, vol. viii, pp. 231, &c.,) added three new species from the cretaceous beds, *L. simplex, inflata*, and *balanophylloides*. A sixth one occurs in Southern India.

LOPHOSMILIA SIMILARIS, *Stoliczka*. Pl. II, Fig. 6.

Loph. corallum sub-cylindraceum, modice elevatum, parte inferiori paulo contractum atque basi lata irregulari sessile; sectione elliptica; costis æqualibus, latis, prope calicem distinctissimis, sub-granulosis; calice paulo contracto, concaviusculo; septis in quinque cyclis dispositis, cyclo ultimo in specimine unico, ut videtur, imperfecto, modice undulatis, septis primi atque secundi ordinis terminationibus internis paulum incrassatis; columella circiter quartam partem diametri majoris longa, undulata, quasi quadrilobata.

The single specimen bears a great resemblance to Fromentel's *L. inflata*; it has a similar sub-cylindrical stem, sessile by a broad base; the costæ are all equal and sub-granular; the calyx was also little contracted, with the edges of the costæ somewhat projecting, but it had to be filed off in order to show clearly the disposition of the septa. Of these there are four complete, and a fifth apparently incomplete cycle; the primary and secondary ones are conspicuously thickened at the inner ends. The columella equals in length about one-fourth of the longer diameter; it is somewhat undulating, as if it were four-lobed, a circumstance which supports M.-Edwards and Haimes' statement regarding the identity of *Lophosmilia* and *Actinosmilia*.

Locality.—Near Odium, in a yellowish limestone.

Formation.—Ootatoor group.

Lophosmilia is closely allied to *Placosmilia*, but while in the former the corallum is usually of small size with the costæ most distinct near the calyx, with the septa generally somewhat attenuated at the inner ends, and with a very small number of dissepiments, the same is in the latter generally of moderate size with the costæ well developed in the entire length, with the septa internally usually thickened or truncated, and with very numerous dissepiments.

Of *Placosmilia*, adopted in this signification, only a single fragmentary specimen has been found east of Parally in a calcareous rock belonging to the lowest beds of the Ootatoor group.

The specimen, see figs. 7 and 7*a* on plate ii, has the outer surface covered with sharp, unequal granular costæ, of which three subequal ones are interposed between two stronger ones. The section of the corallum is elongately oval, with a columella equalling one-third of the longer diameter. There are five complete cycles, and a sixth incomplete cycle of septa, those of the first and second order being truncate at the inner ends; the dissepiments are very numerous. Until better specimens have been discovered, it will not be possible to give a reliable characteristic of the species, or to identify it with any other previously known.

VI. *Genus.*—EPISMILIA, *Fromentel*, 1859.

Corallum sub-cylindrical, or more or less compressed and conoid, attenuated at the base or shortly pedicellate, covered with a well developed epitheca, the costæ being indistinct; the calyx is ovate or round, according to the form of the stem, apparently very slightly concave in the centre; the septa are in six systems, smooth or nearly smooth at the sides; dissepiments abundant; no columella is present.

I have slightly altered Fromentel's characteristic, because it appears to have been framed almost only with reference to the two species which that author describes. When the roundness or slight compression, or a more or less pedicellate shape, of the corallum is not considered to possess generic value in the case of *Trochosmilia*, *Placosmilia* and others, it is only a natural consequence not to admit it in the closely allied *Epismilia.*

The genus differs from *Trochosmilia* by its well developed epitheca and laterally smooth or nearly smooth septa; the last character also separates it from *Montlivaultia.* It includes a few jurassic and two cretaceous species, to which one is added from South India.

EPISMILIA CRASSISEPTA, *Stoliczka.* Pl. II, Figs. 8—9.

Epism. corallum sub-cylindraceum, vel obverse conoideum, crassum, basin versus angustatum, ad intervalla irregulariter constrictum, brevissime atque abrupte pedicellatum, basi arcuata vel torta ac angusta affixum; epitheca rugulose striata; calyce rotundato, paulum exserto, ad marginem sub-rotundato, medio impressiusculo; septis in quinque cyclis dispositis, cyclo ultimo sæpissime imperfecto, sub-flexuosis, primariis crassissimis, medio fortissimis, ad terminationes internas valde attenuatis, sequentibus gradatim in magnitudine decrescentibus, lateraliter minutissime denticulatis; spatio columellari centrali haud elongato, parvo.

A large sub-cylindrical or obversely conoid species with an abruptly contracted and somewhat twisted, shortly pedicellate base; the epitheca is very strongly, but irregularly developed, the corallum being at intervals more or less contracted, and becoming in places quite irregularly rugose; the calyx is round, slightly exsert, apparently with rounded or obtuse edges and an impressed centre. The septa are very strong, in five cycles, the fifth cycle is, however, mostly incomplete; all the septa are somewhat flexuous, attenuated at their inner ends, the primaries being greatly thickened about the middle; the following septa gradually decrease in strength; their sides appear smooth to the naked eye, but with the lens a very fine crenulation or denticulation is traceable on most of them.

The strength of the septa, between which the dissepiments and the endotheca are very much developed, and the roundness of the stem, readily separate the present species from the two others known from cretaceous deposits.

Locality.—North-west of Moraviatoor, in a brownish limestone.

Formation.—Ootatoor group.

VII. *Genus.*—PSAMMOSMILIA, *Fromentel*, 1863.

Pal. Franç. terr. cret., vol. viii, p. 288.

Corallum sub-cylindrical, attached by a broad base and with a rounded shallow calyx; mural theca finely granulated or nearly smooth, formed by super-imposed layers, without any costæ; septa in six systems, laterally granular or striated; no columella.

The genus differs from *Cœlosmilia* and other allied forms by the entire absence of costæ. There is as yet only a single species known, *Ps. Orbignyi*, From., from the Cenomanien beds of the island of Aix.

PSAMMOSMILIA ORIENTALIS, *Stoliczka*. Pl. II, Figs. 10 & 11.

Psamm. corallum plus minusve elongate sub-cylindraceum, basi lata sessile, modice arcuatum, superficie concentrice irregulariter paulo constrictum, sub-lævigatum, calycem versus gradatim dilatatum; calyce sub-rotundato, concavo, margine tenui ac simplici instructo; septis in quatuor cyclis dispositis, lateraliter granulato striatis, primariis crassissimis sed inæqualibus, iis ad cyclum quartum pertinentibus minimis, nonnunquam fere obsoletis.

Although the two, as yet known specimens of this interesting species, are only partially weathered out of a solid limestone rock, both the generic and specific characters are quite sufficient to distinguish the Indian fossil from the European one. There is not a trace of costæ present, and the mural theca appears to have been almost smooth, or only very finely granulated. The edge of the calyx is thin, entire, and the septa not so prominent, as in *P. Orbignyi;* those of the fourth are sometimes partially imperfectly developed, which appears to be due to a slight irregularity in the growth of the calyx.

Locality.—South of Cooticaud, in a whitish limestone.

Formation.—Ootatoor group, (Cenomanien).

Family,—STYLINIDÆ.

Compound massive coralla, in which the multiplication of the corallites is basal or extra-calicinal, and the calyces are entirely free, connected with each other by a costal murail; dissepiments are abundant; the septa entire on the upper edge.

This group corresponds to the STYLINACEÆ of M.-Edwards and Haime, by whom it is regarded as a sub-division of the EUSMILINÆ, which again are considered as a sub-family of the *ASTREIDÆ* in the old sense. The above noticed characters easily separate the *STYLINIDÆ* from other allied families, such as the *ASTREIDÆ (sensu stricto)*, which have the edges of the septa granular or dentate.

The South Indian cretaceous deposits have yielded only two genera belonging to the present family, *Stylina* with three, and *Phyllocœnia* with a single species; all four are new to science.

VIII. *Genus.*—STYLINA, *Lamarck*, 1816.

Hist. Nat. des Corall., tome ii, p. 232.

Massive, generally semiglobose, rounded or flatly expanded coralla, in which the corallites are united by a dense costal or mural theca; the costæ are well developed; the septa entire, in six systems, the calyces usually deeply excavated, of a rounded circumference, with raised edges; the columella styliform.

D'Orbigny divided this genus, as defined by Milne-Edwards in his early monograph* of the *Astreidæ*, into more than half a dozen distinct genera, taking as points of distinction either the form of the corallum or the number of well developed systems of septa. These characters the authors of the history of corals consider as unreliable for the purpose of forming new genera, and retain the unity of the genus *Stylina* in the form characterized above. This appears a very correct view of the facts, for a greater variability, than occurs in the form of the corallum, and to a large extent also in the development of the septa, among these compound corals, can scarcely be met with. Even the presence or absence of a columella is not always absolutely constant, for in some calyces on one and the same corallum I could discover scarcely a trace of a columella, while most of the other corallites had it very distinctly developed. From this fact it is clear that the genus *Cyathophora* is very closely allied to *Stylina*, and I dare say instances may occur where it is impossible to separate both.

In order to facilitate the determination of the species Milne-Edwards and Haime have divided the genus into several groups, chiefly according to the equal or unequal development of the systems, and then according to the number of cycles. In the South Indian cretaceous deposits three species have been found, one belongs to a group with only very few septa of the fourth cycle, while the two others are referable to a section of chiefly jurassic species with regular six systems and only two complete cycles of septa.

1. Stylina multistella, *Stoliczka*. Pl. III, Figs. 1 & 2.

Styl. corallum subglobosum seu late explanatum, infra subpedicellatum vel concavum; calycibus in superficie supera irregulariter dispositis, 4 ad 5 mm. latis, modice distantibus atque elevatis, profunde ac infundibiliforme excavatis; septis crassis, intus attenuatis in duobus cyclis dispositis, crassioribus atque tenuioribus alternantibus; columella tenui, profunde sita.

The form of the corallum is very variable, either semiglobose with a concave lower side, or more or less expanded and with a flattened upper side. One of the largest specimens measures 160 mm. in length, 140 in breadth, and about 55 in thickness, the lower side being subpedicellate, the upper only very slightly convex.

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* Ann. des sc. nat., 3me ser., vol. x.

Older and younger calyces are irregularly distributed over the surface and are moderately distant from each other. Each is about 4 to 5 mm. in diameter, and all are deeply excavated with sloping sides and two complete cycles of strong septa; the secondary septa being somewhat thinner than the primaries; most of the costæ are confluent with those belonging to the next calyx, others are not; dissepiments are very abundant; the columella is very deeply situated and thin at its upper end. In weathered specimens (see fig. 2) the calyces are apparently larger, with perpendicular walls, and the septa become more or less detached from the costæ.

Locality.—North-west of Moraviatoor, in a brownish limestone; several specimens have been found together with *Amm. Rotomagensis* and *rostratus.*

Formation.—Ootatoor group.

2. STYLINA GRANDIS, *Stoliczka.* Pl. III, Fig. 3.

Styl. corallum eo speciei præcedentis simile, sed crassius, calcibus majoribus,– 6 *ad* 7 *mm. latis,– magisque elevatis, atque inter se distantioribus (*12 *ad* 15 *mm.), septis in duobus cyclis dispositis, crassis, subæqualibus, subcarinatis, interspatiis polypidum satis excavatis; calycibus perprofundis; columella profunde sita, crassiuscula.*

A species similar to the preceding, but with much larger and more elevated polypides, the calyces varying from 6 to 7 mm. in diameter; the septa are strong, almost carinate and subequal; the secondaries not differing very much in strength from the primaries; all descend rather rapidly into depth of the calyx.

Locality.—Near Kauray, in a sandy limestone; only a single large but imperfect corallum, 130 mm. long, 110 broad and 60 thick, has been found.

Formation.—Ootatoor group.

3. STYLINA PARVULA, *Stoliczka.* Pl. IV, Fig. 6.

Styl. corallum agariciforme vel subglobosum, breviter pedicellatum, basi latiuscula affixum, aut irregulariter rotundate expansum, deplanatum, epithecá radiatim striatulá tectum; calycibus rotundatis, circ. 2 *mm. latis, margine modice elevato circumdatis,* 1·5 *ad* 2, *rare* 3, *mm. distantibus, subæqualibus; septis valde inæqualibus, tenuibus, plerumque* 28, *rariter* 30, *in tribus cyclis perfectis dispositis, cyclum quartum in uno systemate solum exhibente; costis confluentibus, attenuatis; columella crassa, solida, medio calycis umbonata, semiglobosa.*

The form of the corallum is either convex, subglobose, or more or less depressed, sessile by a broad base, or with a very slightly developed and short peduncle; the lower side has a striated epitheca; the upper is covered with calyces, sometimes overlapping the edges of the corallum and extending on to the lower side. The calyces are about 2 mm. wide, rounded, with moderately elevated margins, and generally only

1·5 to 2 mm., very rarely 3 mm., distant from each other. There are in most of the calyces three complete cycles of thin and very unequal septa, and in one system there are four septa of a fourth cycle, rarely are one or two more septa in any of the other systems present. The costæ are well developed, confluent; the columella thick, terminating in the centre of the calyx with a large round, prominent knob.

Locality.—Ninnyoor, in a white, earthy limestone; four specimens have been examined; the largest measures 70 mm. in diameter.

Formation.—Arrialoor group, of which the present species appears to be a very characteristic fossil.

IX. *Genus.*—PHYLLOCŒNIA, *Milne-Edwards* and *Haime*, 1848.

Hist. Nat. des Corall., vol. ii, p. 272.

A generally massive corallum with the corallites united by the costæ and the exotheca; gemmation lateral; the calyces have slightly elevated margins; septa well developed in six systems; dissepiments very abundant; columella generally absent, sometimes apparently rudimentary.

Species of this genus occur in cretaceous as well as in tertiary deposits.

PHYLLOCŒNIA MULTISEPTA, *Stoliczka*. Pl. III, Fig. 4.

Phyll. corallum agglomeratum; calycibus rotundate polygonis, marginibus paululum elevatis; costis in interspatiis fere obsoletis; septis in quatuor cyclis dispositis, lateraliter minute granulatis; columella nulla.

This species is based upon a rather imperfect specimen, but it appears to be a true *Phyllocœnia*, the columella being entirely absent; there are, however, in some of the corallites lamellæ projecting, which appear quite to close up the columnar space; dissepiments are very abundant. The margins of calyces are very slightly raised, and the costæ between them very imperfectly traceable. The inner ends of the primary and secondary septa are somewhat thickened, and all granulated.

Locality.—North of Alundanapooram, in a coarse conglomeratic sandstone.

Formation.—Trichinopoly group.

Family,—ASTREIDÆ.

This family includes compound massive coralla, with basal or sub-marginal gemmation of the individuums, the calyces being connected by a costal murail; the septa are always granular or serrated on their upper edges.

Taken in this sense, the *ASTREIDÆ* correspond to Milne-Edwards and Haime's sub-family *ASTREINÆ*, with the exception of the *LITHOPHYLLIDÆ* and of *MONTLIVAULTIA*, which have been already separated by Fromentel. The same author gives, it is true, a much more restricted sense to the *Astreidæ*; for, according to the above noticed characteristic, it will also include his *Latomæandridæ*, *Symphyllidæ*, *Favidæ*, and two or three others. It is possible, and I should say very desirable, that a few separate groups or families should be distinguished; but, for reasons already referred to, I hardly think that this can be done with advantage in the form introduced by Fromentel. It is often, in imperfect specimens, very difficult to decide in what manner the multiplication of the corallites takes place, and until all these and other points in structure have been satisfactorily settled, it will be, I think, for our purpose more advantageous to retain the extent of the *Astreidæ* in the older sense. In conformity with this, the family is divided into two groups according to whether the multiplication of the corallites takes place by fissiparity, or by sub-marginal gemmation; the former may be called *symphyllinæ*, the other *astreinæ* (excluding the *Thamnastreidæ*). Between these two sub-divisions come the *faviinæ*.

The *symphyllinæ* are represented in South India by the following genera; *Thecosmilia* with one, *Holocœnia* with two, *Astrocœnia* with four, *Mycetophyllia* with two, and *Stelloria* with one species; the *astreinæ* have only four genera, *Heliastrea* with three, *Placastrea* (n. gen.) with one, *Isastrea* with five, and *Latimæandra* also with five species. Thus we have in all twenty-four species of *Astreidæ*, but two or three remain somewhat imperfectly known.

X. *Genus.*—THECOSMILIA, *Milne-Edwards* and *Haime*, 1848.

Hist. Nat. des Corall., vol. ii, p. 354.

The corallum is composite, cæspitose, sometimes forming large aggregate masses connected together by a well developed epitheca, but the single individuums generally become free near the calyx, and the epitheca reaches very nearly or fully to its edge; the calyx is slightly impressed in the centre with somewhat irregular edges; the septa, arranged in six systems, are laterally distinctly granular; in typical specimens no columella is present, but a few aberrant forms have traces of it; the endotheca is abundant.

All the species, as far as known, are, I believe, fossil, and the majority from mesozoic deposits, particularly cretaceous and jurassic.

Thecosmilia geminata, *Stoliczka.* Pl. IV, Figs. 1—3.

Thecosm. corallum breviter cæspitosum, bi- vel poly-geminatum, calycibus subrotundatis, attingentibus, theca crassa comuni circumdatis, in junioribus fere planis, in adultis modice convexis, medio paulo concaviusculis, epitheca usque ad marginem calycis extensa; septis crassis in quatuor aut quinque cyclis dispositis.

This is a very remarkable species, in some respects intermediate between *Euphyllia* and *Thecosmilia*; the presence of a strong epitheca appears, however, to show a decidedly greater relation to the latter genus, though in other respects it also closely approaches certain tertiary species of *Latimæandra* and *Heterogyra*, but the fossils are not sufficiently well preserved to ensure a thoroughly satisfactory determination of the genus. The corallum is shortly cæspitose and sessile; the single individuums, although entirely free below, cemented by the epithecal mass, are not perfectly separated on the outer surface, the calyces touching each other in a long line by two and two, and thus producing a greater or lesser irregularity in the rounded shape of the calyx. The epitheca reaches up to the margin of the calyces and surrounds them; the latter are rather flat in young, but more elevated in older specimens; the first have four, the second five cycles of septa, but the last cycle appears to remain incomplete; all the septa, except those of the last cycle, are very strong, thickest about the middle of their length, much attenuated towards and almost meeting in the centre; their sides are very distinctly granular.

The strength of the septa and the projecting epitheca at the edge of the calyx exhibits certain relations to similar characters in ***Thecosmilia (Euphyllia?) sinuosa***, Reuss, (Denksch. Akad., Wien, Math. Naturwiss. Klasse, 1854, vol. vii, p. 92, pl. 17, fig. 3), from the Alpine Gosau deposits, but the greater isolation of the calyces in the Indian form readily proves its specific distinctness.

Locality.—North-west of Moraviatoor, in a light brownish limestone, apparently not common.

Formation.—Ootatoor group.

XI. *Genus*.—HOLOCŒNIA, *Milne-Edwards* and *Haime*, 1851.

Hist. Nat. des Corall., vol. ii, p. 249.

Corallum solid, globular or branched, with the calyces irregularly distributed over the surface, connected by short, confluent costæ, which extend from the septa so as somewhat to obliterate the edges of the calyces; septa serrated, thin, arranged in six systems; columella solid and large.

This genus was proposed by Milne-Edwards and Haime for a lower cretaceous species of a globular shape, *Astrea micrantha*, Römer, which was subsequently also found in the Dept. de l'Yonne. In the description of that species, the authors of the Hist. Nat. des. Corall. distinctly state that the septa are serrated, and the same is to be observed in at least one of two Indian species. It is, therefore, clear that the genus cannot belong to the *STYLINIDÆ*, but has to be referred to the *SYMPHYLLINÆ* of the *ASTREIDÆ*.

1. HOLOCŒNIA RAMOSA, *Stoliczka*. Pl. IV, Figs. 4—5.

Holoc. corallum crasse ramosum, ramis cylindraceis aut sub-compressis; calycibus undique sparsis, rotundatis aut rotundate sub-angulatis, 1·5 *ad* 2 *mm. latis atque* 1 *ad* 1·5 *mm. inter se distantibus, eorum marginibus in superficie perfecta paulo elevatis, costis transeuntibus crenulatis; septis in tribus cyclis perfectis dispositis,* *iis ad primum atque secundum cyclum pertinentibus æqualibus, cæteris multo tenuioribus ac brevioribus, omninis minute serratis lateraliterque dense spinulatis; costis brevibus, granulatis, in depressionibus inter-calicularibus paulo attenuatis atque plus minusve distincter confluentibus; columella solida, percrassa.*

Corallum generally forming dichotome, round or somewhat compressed branches, on which the calyces are irregularly and rather densely distributed. They are round or roundly polygonal, on a well preserved surface with somewhat raised margins, which are crenulated by the costæ passing over the same. When the surface is not well preserved, the calicular margins become obliterate by the costæ, and appear more depressed than the interspaces. The width of the calyces varies from 1·5 to 2 mm., and they are one to one and a half mm. distant from each other. There are three complete cycles of thin septa, all finely serrated on the upper edges, and laterally densely spinulose; those of the first and second cycle are equal in strength and length, extending to the very massive and solid columella; those of the third cycle are much shorter and thinner. On a section the costo- mural theca is rather coarsely and irregularly granular. (See fig. 4*b*).

Locality.—Moraviatoor, in a brownish limestone; not uncommon.

Formation.—Ootatoor group.

2. HOLOCŒNIA INDICA, *Stoliczka*. Pl. V, Fig. 1.

Holoc. corallum irregulariter expansum, depressum, superficie supera undulate planatum; calycibus confertis, approximatis, sub-rotundatis, 1·5 *mill. latis, margine paulo elevato circumdatis, depressionibus angustissimis separatis, costis brevissimis in marginibus calycum tuberculiforme elevatis; septis in duobus cyclis dispositis, sex majoribus cum sex multominoribus atque brevioribus alternantibus; columella solida, crassiuscula.*

In general character the present species resembles an *Astrocœnia*, but the calyces are well defined, rounded, their edges crenulated by the very short costæ. There are, as a rule, only two cycles of septa developed; very rarely are a few very short ones of a third cycle noticeable. Scarcely any of the calyces exceed 1·5 mm. in width. I have not been able to see whether the upper edge of the septa is crenulated; laterally there are only few very minute denticles to be observed.

Locality.—Ninnyoor, in whitish limestone; only three specimens, the larger of which is 75 mm. long and 50 mm. broad, have been found.

Formation.—Arrialoor group.

XII. *Genus.*—ASTROCŒNIA, *Milne-Edwards* and *Haime*, 1848.

Hist. Nat. des Corall., vol. ii, p. 254.

Compact coralla of a globular, sub-globular, or more or less ramified shape, on which the calyces are irregularly distributed and close together, polygonal, separated by granules or rudiments of septal costæ; the columella is styliform, solid, somewhat projecting in the middle of the calyx; the septa are granular, arranged in six cycles, but sometimes apparently in eight or ten, some of those of the second cycle being equally strongly developed as those of the first.

The species of this genus only differ from *Stylocœnia* by the want of projections at the angles between the calyces, and as these become occasionally or locally in some (particularly tertiary) forms of the latter genus obsolete, several authors consider the distinction of the two genera as doubtful, suggesting that the character alluded to should only be used as facilitating an easier grouping of the species, all referable to one genus. The ramose species have been called ***Enallocœnia*** by d'Orbigny, but the mere mode of growth is justly rejected by Milne-Edwards and Haime as a character of generic value.

Reuss first observed the granulation of the septa. In ***Ast. Konincki*** or ***decaphylla*** of the Gosau, for instance, the granulation of the upper edge of the septa is very distinct, and the genus must, therefore, be transferred from the *Stylinidæ* to the *Symphyllinæ*, treated by Milne-Edwards and Haime as a sub-family of the *Astreidæ*.

The typical species of ***Astrocœnia*** are known from mesozoic and cainozoic deposits. Only recently a few recent species had been referred to it, but they apparently require a verification of the generic determination. Pourtalè's (Illust. Cat. Museum Comp. Zool., No. iv, Deep Sea Corals, 1871, p. 69,) describes a new recent species as ***Ast. pectinata***, incrusting the base of a ***Madrepora***. The author says in the description "costæ spinous, generally not confluent," columella rather stout, conical, hollow, free to a considerable depth; calyces 1·5 mm. wide.

The species occurring in the South Indian cretaceous deposits arrange themselves as follows:—

a. 1. With six primary septa—in three complete cycles,—calyces 2—3 mm., *A. retifera*, n. sp.
2. „ „ „ —in two cycles—calyces 1·2 to 1·75 mm., *A. Reussiana*, n. sp.
3. „ „ „ — „ „ calyces 1 mm., *A. pumila*, n. sp.
b. 4. With ten principal septa—in three complete cycles—*A. decaphylla*, Mich.

1. Astrocœnia retifera, *Stoliczka*. Pl. V, Fig. 2.

Astroc. corallum crassum, semi-globosum, aut tuberosum; calicibus attingentibus, polygonis, (plerumque irregulariter hexagonis) 2 ***ad*** 3 ***mill. latis, marginibus unitis elevatis, tuberculis crassiusculis ornatis; septis in tribus cyclis perfectis***

dispositis, nonnunquam duobus vel tribus septis ad cyclum quartum pertinentibus in uno systemate observandis; septis indistincte granuliferis; columella mammillata.

This species forms large convex or nodular masses, some of them averaging one foot in diameter, and they are nearly quite as high. The calyces are generally polygonal, mostly hexagonal, and the united raised margins are ornamented with a single row of well marked tubercles. The septa are arranged in three complete cycles and six systems; sometimes there are two or three septa of the fourth cycle developed in one of the systems; all are provided with somewhat flattened granules on their upper edges; the columella is of moderate size, forming a conspicuous hemispherical knob in the centre of each calyx.

In general character this species resembles *Ast. Konincki, (A. magnifica,* apud Reuss), but it differs from it by the number of septa. There is, I think, as yet no cretaceous species known with three complete cycles of septa regularly arranged in six systems.

Localities.—Ootatoor, east of Kauray, north-west and north-east of Moraviatoor; common in brownish or whitish limestone.

Formation.—Ootatoor group.

2. ASTROCŒNIA REUSSIANA, *Stoliczka.* Pl. V, Figs. 3—4.

Astroc. corallum semi-globosum, aut late planeque expansum, crassum; calycibus 1·2 *ad* 1·75 *(rare 2) mm. latis, polygonis, modice distantibus, margine quoque spinulose tuberculifero; septis in duobus cyclis dispositis, primariis usque ad columellam solidam crassiusculam extensis, secundariis paulo brevioribus, rariter septis nonnullis brevissimis ad cyclum tertium pertinentibus observandis.*

This species is somewhat allied to *A. Tourtiensis,* Bölsche (in Geinitz's 'Elbethalgebirge in Sachsen,' part i, 1871, p. 54), differing from it by more distant calyces, which have very distinctly and spinulously tuberculated margins. There are, as a rule, only two cycles of septa, those of the second cycle being conspicuously shorter than those of the first, while in the European species the two are of equal length. Sometimes there are some very short septa of a third cycle developed in the larger calyces. The coralla are very massive, either semi-globose, or with a flattened upper surface. One of the largest specimens is 110 mm. long, 60 broad, and equally high.

Localities.—Odium, Moraviatoor, and east of Kauray; mostly in a brownish or pinkish limestone.

Formation.—Ootatoor group.

3. ASTROCŒNIA PUMILA, *Stoliczka*. Pl. IV, Fig. 7.

Astroc. corallum parvum, sub-globosum, calycibus minutis, approximatis, polygonis 0·7 ad 1 mill. latis, profundiusculis, marginibus tuberculis crassis spinulosis, paululum alternantibus ornatis; septis in duobus cyclis perfectis dispositis; columella sub-mammillata.

A remarkably small form of a sub-globular shape, and with the calyces from 0·7 to 1 mm. wide; they are polygonal, moderately excavated, and the united margins are crowned with a row of rather strong, sharp, and somewhat alternately placed tubercles, so as to form a slightly undulating row. There are only two complete cycles of unequal septa, regularly arranged in six systems. The columella is styliform, with a sub-mammillate upper end. The small size of the calyces readily distinguishes the present species from all other known *Astrocœniæ*. As regards general character one of the nearest allied species is Bölsche's *Ast. Tourtiensis*[*] from the lower Plæner near Plauen; but this has not only larger calyces, but also a larger number of septa.

Locality.—Ninnyoor, in a whitish earthy limestone; only the figured specimen has been examined.

Formation.—Arrialoor group.

4. ASTROCŒNIA DECAPHYLLA, *Micheliu*. Pl. V, Figs. 5 & 6.

1847. *Astrea decaphylla*, Michelin, Icon. Zoophytol., p. 302, pl. 72, fig. 1.
1854. *Astrocœnia ead.*, apud Reuss, Denksch. Akad., Wien, Math. Nat. Klasse, vol. vii, p. 94, pl. 8, figs. 4—6.
1857. „ „ Mil.-Edwards and Haime, Hist. nat. des Corall., ii, p. 258.

Astroc. corallum globosum aut semi-globosum, nonnunquam incrustans; calycibus polygonis plerumque duo, rariter tres, mill. latis, polygonis, interspaciis subcristatis, aut depresse latiusculis, et granulatis separatis, viginti septis majoribus atque minoribus alternantibus, granuliferis instructis; columella solida, ad terminationem superam sub-mammillata.

Corallum more or less globular or sometimes incrusting other substances with smaller and larger calyces irregularly disposed. The latter are polygonal and generally have a diameter of two, rarely three millimeters; they are separated by simple tuberculated ridges, the tubercles being placed somewhat alternately, and when the surface is somewhat worn off, they give the appearance of two separate rows; on a polished surface these two rows become still better traceable. The septa are twenty in all, alternately shorter and longer, four of the second cycle being quite as strong as those of the first cycle; of the third cycle only eight are present, all are granular on the upper edge and laterally finely denticulate. The columella is sub-mammillate at the upper end, thicker in some calyces than in others.

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[*] Geinitz's Elbethalgebirge in Sachsen, pt. i, 1871, p. 54, pl. xi, figs. 7 and 8.

M.-Edwards and Haime give the diameter of the calyces at 3 mm.; this, however, is rarely the case. In several specimens from the Gosau by far the greater number of the calyces are only two mm. in average; the same is to be observed in Michelin's original figure, and in a South Indian example.

Locality.—North of Alundanapooram, in a coarse sandstone; and near Ninnyoor, in white sandy limestone; only the two figured specimens have been found; the upper surface is a good deal worn off; but the characters of the species are unmistakable.

Formation.—Trichinopoly and Arrialoor groups.

The species also occurs in the Turon beds at Bains-de-Rennes (Corbières), in the Gosau deposits of the Gosau valley and near Piesting in Lower Austria.

Besides the small specimen from Ninnyoor there is a second large ramose specimen in the collection from the same locality. The general growth of this specimen is somewhat different from that of *decaphylla;* the calyces are polygonal with raised margins; larger and smaller ones are irregularly distributed, measuring from two or three to four mm. in diameter, a few even five mm. The smaller calyces have ten long and ten short septa, exactly as in typical *decaphylla;* the larger ones have twelve larger and as many shorter; thus regularly three cycles in six systems. The columella is thick and solid. As the only specimen is not perfectly well preserved, it is difficult to say whether we have in this branched form only a variety of *Act. decaphylla* before us, or a really distinct species.

XIII. *Genus.*—MYCETOPHYLLIA, *Milne-Edwards* and *Haime*, 1848.

The corallum is massive and sessile by a more or less expanded base, covered with a thin epitheca; the corallites are united by their costo-mural theca, forming shorter or longer variously twisted series; the costæ are very short, and, like the septa, sharply and nearly equally serrated, the latter being in a small or moderate number present; the calyces are very shallow and the dissepiments very abundant, filling up the inter- septal space to very near the top of the calyx; columella absent or rudimentary.

There are only a few recent and tertiary and one cretaceous (*M. antiqua*, Reuss, from the Gosau) species known. They are easily distinguished by the moderate number of septa and the shallow calyces filled up with endotheceal dissepiments.

1. MYCETOPHYLLIA NOBILIS, *Stoliczka.* Pl. VI, Fig. 1.

Myc. corallum solidum, supra leviter convexum, infra basi angustata affixum, epitheca tenui, vix striatula tectum; calycibus in seriebus varie tortis, plus minusve elongatis confluentibus, 10 *ad* 15 *mm. latis, interdumque latioribus; costis attenuatis brevissimis, continuis, nonnunquam thecâ intercostali junctis; septis in quatuor cyclis dispositis, cyclo quarto sæpissime imperfecto, iis ad primum atque secundum cyclum* *pertinentibus fortissimis, fere æqualibus, omnibus subcristatis atque granuliferis; columella obsoleta.*

A large and apparently typical species of the genus, having a massive corallum, above convex, below somewhat attenuated, and covered with a thin epitheca. The calyces generally vary from 10—15 mm.; some are occasionally even larger, all very shallow, filled up by very numerous dissepiments to near the top. The large calyces have four nearly complete cycles of septa, those of the two first cycles being almost equal in strength; smaller calyces have the fourth cycle incomplete, or not at all developed; all the septa are considerably attenuated, equally and rather finely serrated on their upper edges. There is no apparent trace of a columella.

Locality.—North of Alundanapooram, in a grey, coarse, calcareous sandstone; only the figured specimen has been examined.

Formation.—Trichinopoly group.

2. ? MYCETOPHYLLIA STELLATA, *Stoliczka*. Pl. V, Fig. 7.

A small round corallum, about 25 mm. in diameter and 10 in height, with the upper surface moderately convex, the lower covered with a thin concentrically rugose epitheca, and about the centre with a somewhat irregular rather broad place of attachment. The gemmation is extra calicular, as in *Mycetophyllia*. The calyces are irregularly distributed over the surface, more or less confluent, smaller and larger ones interposed between each other, and of a small depth. The larger and perfect calyces have two cycles of septa; those of the first very thick, crested, laterally strongly ribbed or dentate; those of the second much shorter. In the smaller, or in the more or less confluent calyces, the development of the septa is by no means so regular. The costæ are indistinct and short, and the calyces separated by confluent variously twisted ridges.

I notice this species only provisionally under the above generic name for want of a more appropriate one, but it most probably belongs to a new genus. The single specimen is, however, not in a sufficient state of preservation to characterize a new generic division. The fossil exhibits, as regards the form of the septa, some relation to that described from the Gosau by Prof. Reuss under the name of *Aræacis lobata*, (Denksch. Akad., Wien, Math. Nat. Klasse, vol. vii, p. 83, pl. xiii, figs. 13 and 14).

Locality.—East of Parally, in a coarse sandstone.

Formation.—Ootatoor group.

XIV. *Genus.*—STELLORIA, *d'Orbigny*, 1849.

Corallum massive, with the polypierites directly connected by their mural theca, radiating from a central point and extending to the periphery, with new intercalated series; centre of the calyces quite indistinct, the columella is rudimentary or absent.

The type of this genus is an upper cretaceous fossil, described by Michelin as *Anthophyllum sulcatum;* it has at the first glance the appearance of a Turbinolid coral, but its proper position is no doubt in the *Astreidæ*. M.-Edwards and Haime doubtfully refer two other species to the genus, one *St. rustica*, d'Orb., known from a very brief characteristic, and the other *St. agaricites*, (Goldf.), described by Reuss as *Latimæandra* from the Gosau. From any of these species the single fragment of a true *Stelloria* from South India is different, and I shall refer to it under the name of

Stelloria Arcotica, *Stoliczka*. Pl. V, Fig. 8.

It is a segment of a broadly conoid corallum, about 40 mm. in diameter and 18 in height. The lower surface is costulate, but evidently much worn off. On the upper surface the calicular series radiate from the centre,* slightly undulating, and in their course alternating with shorter ones; there is no columella, and the septa are coarse, about half a mm. distant; the ridges are divided by a solid undulating lamina, from which the septa, so to say, issue on either side almost vertically. Long dissepiments are to be observed at distances.

The septa are granular on the upper edges, and laterally unequally and sparingly denticulated. Until better preserved specimens have been found, a more detailed characteristic must be deferred.

Locality.—East of Parally, in brown limestone.

Formation.—Ootatoor group.

Sub-family,—ASTREINÆ.

XV. *Genus.*—HELIASTREA, *Milne-Edwards* and *Haime*, 1857.

Hist. Nat. des Corall., tome ii, p. 456.

This genus was proposed for a number of recent and fossil species, formerly mostly referred to *Astrea*, but differing from the typical species of this genus (*Madrepora astroites* of Pallas) by the gemmation of the corallites taking place at different heights of the single individuums, but not at the calyx itself. The coralla are massive, generally rounded, covered below by a thin epitheca. The calyces have raised margins, with the costæ well developed and connected by a cellular exotheca. The septa are granular, the primary ones at their inner ends generally thickened; dissepiments numerous; columella spongiose.

1. Heliastrea ortiva, *Stoliczka*. Pl. VI, Fig. 2.

Heliast. corallum crassum, valde expansum, supra planiusculum; calycibus rotundatis vel sub-rotundatis, circa 5 ad 6 mill. latis, marginibus crenulatis modice elevatis circumdatis, irregulariter in superficie dispositis, sub-distantibus; costis

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* Where about twenty of them must have taken their origin.

granulatis inter calyces distinctis; septis in tribus cyclis regularibus dispositis; exotheca late cellulosa.

Judging from a fragmentary specimen, the corallum appears to be largely expanded, with a rather flattened upper surface, and from 30 to 40 mm. thick. The calyces are rounded or roundly ovate, moderately distant and irregularly distributed, with raised margins and granular well marked costæ, which, however, very easily wear off, and then the interspaces between the calyces remain irregularly granular or even smooth. There are three complete cycles of septa, those of the first order conspicuously thickened and not distinctly separable from the large spongiose columella. All the septa are above granular and laterally densely and finely denticulate. The exotheca is formed in almost parallel horizontal layers, and is largely cellular.

Locality.—North of Odium, in a coarse calcareous sandstone; apparently rare.

Formation.—Ootatoor group.

2. ? HELIASTREA, *sp. indet.* Pl. III, Fig. 5.

A fragment of a *Heliastrea*, differing from the previous species by a greater distance of the calyces from each other, has the whole surface so much worn off that no definite characteristic can be given of the species. There are three cycles of septa, but those of the third cycle are very small and sometimes obsolete. The primary septa are attenuated towards the centre. The exotheca is very largely cellular, and in horizontal, parallel layers.

Locality.—South-west of Penangoor; the single specimen is partly silicified.

Formation.—Ootatoor group.

3. HELIASTREA ROTUNDA, *Stoliczka.* Pl. VI, Fig. 3.

Heliast. corallum crassum, orbiculare, supra et infra lente convexum; calycibus 3 ad 4 mill. latis, sub-rotundatis, vel rotundate polygonis, margine paulo elevatis, interspatiis angustis paulisper profundis separatis, septis in tribus aut quatuor cyclis dispositis, cyclo quarto imperfecto, tenuibus, dense atque minute granulatis, lateraliterque minutissime spinulatis; columella lata, spongiosa.

An orbicular corallum, almost equally convex above and below, the upper surface of which is partially cavernose, the cause of which, however, appears to be merely accidental. The calyces are irregularly and rather densely distributed over the entire upper side; they have slightly elevated margins, and are separated by rather shallow and narrow depressions; the diameter of each calyx varies from 3 to 4 mm., and the shape in younger specimens is generally quite circular, approaching to roundly polygonal in the more adult. The septa are thin, granular above, finely denticulate at the sides; there are three complete cycles of them, and the larger calyces have besides a fourth incomplete cycle, the total number of septa thus varying from 24 to 40.

This species is closely allied to *H. Simonyi*, Reuss, from the Gosau deposits, but the latter has somewhat larger and more regularly rounded and elevated calyces.

Locality.—Near Moraviatoor, in a brownish earthy limestone; apparently very rare.

Formation.—Ootatoor group.

XVI. *Genus.*—PLACASTREA, gen. nov., 1873.

Corallum massive; calyces irregularly disposed on the upper surface, closely connected with each other by a septo-costal murail; septa on their upper edge granular, laterally in their entire length equally and rather finely denticulate; columella in its entire length consisting of a solid compressed lamina, with a finely granular upper edge, similar to that of the septa.

This genus differs from true *Astrea* by its entirely solid compressedly columnar columella; the septa are in both equally granular and equally denticulate, but the denticles are in *Placastrea* not enlarged at the inner ends of the septa. Externally in general appearance the genus has very much the character of an *Isastrea.*

A single species occurs in the Ootatoor beds of South India, and I am not acquainted with any other which can be referred to the same genus. It appears to represent *Cyphastrea* in the group of true *ASTREIDÆ*, which have the calyces confluent, not isolated and provided with elevated margins.

PLACASTREA ELEGANS, *Stoliczka.* Pl. VII, Fig. 1.

Placast. corallum irregulariter expansum, modice crassum, sub-pedicellatum, versus marginem tenue, suprâ undulate irregulariter convexiusculum; calycibus plerumque sub-hexagonis, minoribus atque majoribus interpositis, 4 *ad* 7 *mm. latis, modice concavis, costis brevissimis sub-angulate elevatis junctis; septis confertim granulatis, in quatuor cyclis dispositis, cyclo quarto sæpe imperfecto, iis ad primum atque secundum cyclum pertinentibus usque ad columellam fere extensis, cæteris conspicuiter crassioribus; columella compresse styliformi,* 1 *ad* 1·5 *mm. longa, modice exserta, margine superiore minute granulata.*

The only specimen examined is a fragment of a large, apparently planorboid, and sub-pedicellate corallum; its lower surface is much weathered off, so that the probable existence of an epitheca cannot be ascertained; the upper surface is irregularly but slightly convex. The calyces are of rather large size and are moderately excavated, separated by elevated sub-angular ridges, which are crossed by the costæ. There is no regularity to be observed in the arrangement of the calyces, and smaller and larger ones are intermixed. The larger calyces generally have four complete cycles of septa, but in the majority of them the fourth cycle is incomplete; all are finely and rather densely granular on the upper edges, and finely denticulated on the sides.

Locality.—Odium, in brown limestone.

Formation.—Ootatoor group.

XVII. *Genus.*—ISASTREA, *Milne-Edwards* and *Haime*, 1851.

Hist. Nat. des Corall., vol. ii, p. 526.

The solid corallum is very variable in shape, forming more or less convex or depressed masses, sessile by a peduncle or by a large flattened base, sometimes also short branches are produced; the lower side is covered by a striated or costulate epitheca; on the upper the calyces are irregularly distributed, of small or moderate size, close together, generally polygonal, being merely separated by ridges of a comparatively thin costo-mural mass; the gemmation of the calyces takes place near their margins; the septa are numerous, thin, granular above, laterally provided with spinulose equal or very nearly equal granules; they are attenuated at their inner ends; dissepiments are usually abundant; the columella is generally slightly developed, spongiose, or almost obsolete, being replaced by a twist of the inner ends of the septa.

The species of *Isastrea* were believed only to occur in mesozoic strata, extending through all the formations from the Trias to the uppermost cretaceous, but more recently some typical forms were also described from tertiary deposits by Prof. A. E. Ritter v. Reuss. The species appear to have been, however, most numerous and most varied during the jurassic period, particularly the middle division of it; five occur in the South Indian cretaceous beds.

1. ISASTREA EXPANSA, *Stoliczka*. Pl. VII, Fig. 2.

Isast. corallum plane expansum, modice incrassatum, infra epitheca tenuiter striata tectum, supra planiusculum; calycibus poly- (plerumque six-aut septem-) gonis, marginibus elevatis, crasse crenulatis separatis, majoribus 6 *ad* 8 *mm. latis, satis concavis, septis* 48 *ad* 60 *tenuibus, inæqualibus, dense granulatis, lateraliter spinulatis instructis, septo-costis ad primum, secundum atque tertium cyclum pertinentibus in margine unito calycum tuberculiforme elevatis; columella tenuiter spongiosa.*

The peculiarity of this species consists in the costæ corresponding to the three first cycles of septa, becoming sharply subtubercular on the elevated and rather sharply angular margins, which separates the calyces. This character alone separates it from all known *Isastreæ*, as far as I have been able to compare them. The size of the calyces and the great number of septa closely correspond to *I. morchella*, (Reuss), from the Alpine Gosau deposits, but in this species the corallum is always convex, often pedicellate, and the columella in the calyces is much less developed. All the septa are unusually finely and densely granular above and also laterally.

Locality.—Odium, in brown earthy limestone; not common. I have examined three fragments which unmistakably belong to the same species; the largest is figured.

Formation.—Ootatoor group.

2. Isastrea Siva, *Stoliczka*. Pl. VII, Figs. 3—4.

Isast. corallum ovatum, modice crassum, glomeratum aut irregulariter expansum infra epithecá granulato-striata tectum, supra convexiusculum; calycibus polygonis, angustis 3 *ad* 5 *mm. latis, satis profundis, majoribus septa* 36 *ad* 48, *granulifera, dense sita et inæqualia exhibentibus; costis brevissimis, nonnullis in interspatiis elevatis aut subcarinatis cæteris crassioribus; columella tenuiter spongiosa.*

The corallum appears to be rather variable in growth, ovate or irregularly expanded, subpedunculate, and covered below by a striated thin epitheca. The upper surface is undulating, flattened or very slightly convex, with the calyces quite irregularly disposed, polygonal, from 3 to 5 mm. in diameter, and rather concave. They are separated by more or less elevated, angular ridges, over which the septal costæ pass almost without any interruption. Some of the smaller calyces are not even distinctly separated from the adjoining ones, which gives the species rather an aspect of some *Latimæandræ*, or when the inter-calicular ridges are less elevated, that of a *Thamnastrea*. A few of the costæ are on the elevated interspaces generally slightly thicker and more elevated than the majority of the other ribs. The larger calyces have 36-48 granular and closely set unequal septa, shorter and longer ones generally alternating; the number of septa is, however, scarcely in any two calyces the same. The columella is rather small, spongiose, sometimes apparently only formed by the twisted ends of the septa.

The species is closely allied to *I. profunda*, Reuss, (Denksch. Akad., Wien, Math. Nat. Klasse, vii, 1854, p. 116, pl. ix, fig. 6), which has, however, the mural theca, separating the calyces, tolerably well developed, while in the Indian fossil this is almost entirely wanting.

Locality.—North-east of Moraviatoor, in brownish earthy limestone.

Formation.—Ootatoor group.

Two casts of large specimens, weathered out in a brown limestone, are from north-east of Kauray. They generally agree with the typical form from Moraviatoor, but the size of the calyces varies mostly from 5 to 7 mm. Whether this larger size of the calyces merely indicates an individual variation, or really a different species, must be determined from better preserved specimens.

3. Isastrea cyathina, *Stoliczka*. Pl. VII, Figs. 5—6.

Isast. corallum obverse conoideum, parvum, subpedicellatum, basi angustissima affixum seu fere liberum, epitheca lævigata indutum, infra epithecam costis subgranulosis tenuioribus atque crassioribus alternantibus, indistincter fasciculatis, instructum; calycibus sub-quadrangulariter polygonis, paulum profundis, majoribus atque minoribus interpositis, marginibus paulo elevatis unitis, theca costo-murali tenui; calycibus majoribus 8 *ad* 9 *mm. latis, septis* 48-60 *granuliferis, lateraliter* *dense spinulose granulosis, iis ad primum atque secundum cyclum pertinentibus cæteris conspicuiter crassioribus; columella tenuiter spongiosa, distincta.*

A small cyathiform species, with an attenuated stem, terminating pointedly, and covered by a smooth epitheca. The upper surface is moderately convex, with few larger and smaller shallow calyces, separated by elevated margins, on which the septa meet, but without perceptibly increasing in thickness. The larger calyces are in general sub-quadrangular, 8 to 9 mm. wide, while the smaller ones only measure 3 to 4 mm. The former have 48 to 60 granular and laterally densely denticulated septa, of which those of the first and second cycle are conspicuously stronger than the others. The columella is well developed, thinly spongiose.

As compared with the size of the corallum, that of the shallow calyces is remarkably great, and this character seems to be peculiar to the present species, distinguishing it from allied forms.

Localities.—Kullay, in a variegated limestone, and east of Parally, in a coarse calcareous sandstone.

Formation.—Ootatoor group.

4. Isastrea morchella, *Reuss.* Pl. VII, Figs. 7—8.

1854. *Latomæandra morchella*, Reuss, Denksch. Akad. der Wissensch. Wien, Math. Nat. Klasse, vii, p. 107, pl. xxi, figs. 9—10.

Isastrea morchella, apud Mil.-Edw. and Haime, Hist. Nat. des Corall., ii, p. 534.

Isast. corallum sub-globosum, supra convexiusculum, breviter aut sub-pedicellatum, aut irregulariter expansum, basi lata affixum, infrâ epitheca costulata indutum, costulis supra granulatis, inæqualibus, ad basin pedicelli elongati sub-obsoletis; calycibus polygonis, 4 *ad* 10 *mm. latis, plus minusve profunde excavatis, plerumque jugis angulatis separatis, nonnunquam duobus adjacentibus confluentibus aut indistincter divisis, theca murali aut septo-costali crassiuscula; septis supra dense granulatis, lateraliter spinulatis, numerosis,* 48 *ad* 65 *in calycibus majoribus, sub-æqualibus; columella tenuiter spongiosa.*

I have compared the Indian specimens with typical ones from the Gosau, and they do not exhibit any essential difference. The form of the corallum varies equally in both places; in the Gosau the majority of specimens found are, however, globose, strongly convex above; in South India the greater number of specimens are sub-pedicellate with slightly convex or even flattened upper surface. The depth of the calyces also changes according to the state of preservation, but they are always concave, separated by well marked ridges, angular when well preserved, obtuse or even flattened when worn off.

The size of the calyces varies from 4—10 mm., the majority are 6 or 7 mm.; in those of larger size generally the beginning of a division may be traced; they are all polygonal, mostly irregularly hexagonal. The septa are finely granular above and laterally; there are from 48 to 65 of them in adult individuums; those of the first and second cycle are equal and extend to the spongiose columella; those of the third cycle are slightly shorter, while the subsequent generally decrease in length, and sometimes connected with each other or with the preceding septa.

Locality.—North of Alundanapooram, in a coarse conglomeratic sandstone; common.

Formation.—Trichinopoly group.

In Europe the species has been found in the coral deposits of the Nefgraben in the Gosau, which deposits, according to the majority of the fossils they contain, appear best to correspond with D'Orbigny's Turonien, a geological position exactly corresponding with that in which the fossil abundantly occurs in South India.

5. Isastrea *conf.* Hörnesi, *Reuss.* Pl. VII, Fig. 9.

A remarkable species with large (6-7 mm. wide) angular calyces and with from 48—60 very thin, granular, laterally thickly spinulated septa of unequal length, and a large spongiose columella.

There is a fragment and an entire corallum, which had been sessile by a somewhat narrowed base, in our collection. The stem is covered with an epitheca, which is near a few concentric swellings, and also near the upper edge costulated, the ribs being in these places granular. The species exhibits, as regards the form of calyces and the number of septa, the greatest relation to *Isast. Hörnesi*, (Reuss), (*Prionastrea eadem*, Denksch. Akad., Wien, Math. Nat. Klasse, vii, 1854, p. 115, pl. xiii, figs. 7-8), but the two Indian specimens are not sufficiently perfect to insure the identity of the species.

Locality.—Moraviatoor, in coarse calcareous sandstone.

Formation.—Ootatoor group.

XVIII. *Genus.*—LATIMÆANDRA, *d'Orbigny*, 1849.

Milne-Edwards and Haime, Hist. Nat. des Corall. ii, p. 543.

Corallum variable in shape, forming globular, subpedunculate, irregularly expanded, or even subdendroid masses, the consistency or solidity of which depends upon the greater or lesser development of the mural theca, connecting the single individuums; the enlargement of the stem takes place by gemmation at or near the edge of the calyces, which are more or less distinctly separated from, or confluent with, each other, and are very variable in form; the columella is rudimentary; septa granular above and spinulosely serrated laterally.

Latimæandra differs from *Isastrea* principally by the tendency of the calyces to become confluent, forming united series. There can be two sections distinguished. The one—called *Chorisastrea* by Fromentel—in which the calyces are separated from each other by more or less distinct depressions, and the second, or true

Latimæandra, in which the series of calyces are separated by united ridges, over which the costæ pass without interruption. These two sections are so intimately connected with each other that authorities on the subject, like Milne-Edwards or Reuss, do not consider a separation into two genera practicable.

I have to notice five species of the genus from South India, only one of which is identical with a European form. This and a new species belong to the second section which I mentioned, while three others are referable to the first.

The *Latimæandræ* occur in all formations, but chiefly in the mesozoic.

a. Sub-genus *Chorisastrea*.

1. LATIMÆANDRA OBCONICA, *Stoliczka*. Pl. VIII, Fig. 1.

Latim. corallum breve lateque conoideum, basi angustissimum, infrâ theca radiatim costellata tectum, costellis granuliferis, supra deplanatum aut minimme convexum; calycibus magnis, irregulariter polygonis, majoribus simplicibus 8 *ad* 10 *mm. in diametro, interdumque duobus aut tribus confluentibus, parum profundis, sulcis angustis separatis; septis crassiusculis, in calycibus perfectis circiter* 35 *ad* 40, *longioribus atque brevioribus plerumque alternantibus, granulatis, lateraliter distanter atque obtuse spinulatis; columella sub-obsoleta.*

The corallum of this species far more resembles that of an *Isastrea* than of a *Latimæandra*, being shortly, broadly conical, and covered by a thin, radiately costulated theca; the upper surface is flattened or slightly convex. The calyces are, however, separated by distinct, though narrow furrows, and among a number of isolated ones there are sometimes two or three united; they are rather shallow or polygonal. The septa are thick at their outer ends, thin interiorly, granular, and laterally provided with moderately numerous spinose subequal tubercles. The columella is in some calyces apparently quite absent, in others there are traces of it.

Localities.—East of Parally, in a coarse calcareous sandstone; north-east of Moraviatoor, in an earthy, brown limestone; rare.

Formation.—Ootatoor group.

2. LATIMÆANDRA GYRINA, *Stoliczka*. Pl. VIII, Figs. 2—3.

Latim. corallum rotundate convexum, sub-pedicellatum, aut irregulariter expansum, infra radiatim striato—costulatum, costulis acutis, subgranuliferis; calycibus irregularibus, satis profundis, paucis simplicibus, plurimis in seriebus elongatis aut varie tortis unitis, sulcis angustis separatis; septis subgranulosis, lateraliter tenuiter spinulosis, subæqualibus; columella sub-obsoleta.

A moderately convex species, with the corallum subpedicellate or irregularly expanded, striately costulated below, the ribs being very sharp and indistinctly granular. The calyces are rather deep, from 5 to 7 mm. in width, separated by narrow furrows; few of them are single, the majority united by two or more, generally in series of five and six, these series being variously twisted. The edges of the calyces are always rounded, or roundly obtuse, but never sharply angular, as is usually the case in the preceding species.

Locality.—East of Parally, in a brownish sandy limestone.

Formation.—Ootatoor group.

3. LATIMÆANDRA CRASSA, *Stoliczka.* Pl. VIII, Fig. 4.

Latim. corallum crassum, irregulariter expansum, supra undulato deplanatum; calycibus circiter decem mm. latis, profundis, in seriebus elongatis, varie tortis, atque sulcis latiusculis separatis, confluentibus, septis crassis, granulatis, circiter 1 mm. distantibus, subæqualibus, tenuissimis, nonnunquam fere obsoletis, cum crassioribus alternantibus.

This species is readily distinguished from all others by the great width of the calicular depressions, and the length and strength of the septa, of which the stronger ones are all about equal and distinctly granular, while the intermediate and very thin ones are sometimes scarcely traceable; the former are generally a little more than one mm. distant from each other, two cycles of them generally meet in one calyx, the less numerous thin septa belonging to the third cycle. The depressions separating the calicular ranges are moderately wide, but rather shallow, and the septal costæ when crossing them considerably decrease in strength. The distance of the centre of one calyx from the next in the same series varies from 10 to 15 mm., while that of one calyx from another in the next adjoining row varies from about 15 to 25 mm.

Locality.—Odium, in a brown calcareous sandstone.

Formation.—Ootatoor group.

b. *Latimæandra*, sensu stricto.

4. LATIMÆANDRA INTERRUPTA, *Stoliczka.* Pl. VIII, Fig. 6.

Latim. corallum irregulariter expansum, tenue, supra undulate convexiusculum; calycibus 4 ad 5 mm. latis, in seriebus varie tortis, sæpe interruptis, irregularibus, dispositis, satis profundis, jugis communis convexiusculis, 2 ad 3 mm. latis, separatis, septis in tribus cyclis dispositis, cyclo tertio imperfecto, dense granulosis, lateraliter spinulatis, octo ad decem cæteris multo fortioribus; columella obsoleta.

The corallum is rather thin, irregularly expanded, with the calyces very irregularly distributed, only from 4 to 5 mm. wide, three or four of them being confluent in variously shaped twisted or curved depressions, separated by elevated ridges, over which the costæ pass without interruption. There are from 20 to 40 septa in one calyx, of which 8 or 10 are much stronger than the rest; but all are very densely granular on their upper edges. In the lengthened calicular valleys about 15 to 20 septa are counted in a length of 10 mm., but those of the third cycle become almost obsolete.

Locality.—East of Parally, in a brownish calcareous sandstone.

Formation.—Ootatoor group.

5. LATIMÆANDRA (? MÆANDRASTREA) CONCENTRICA, *Reuss*. Pl. IX, Fig. 1.

1854. *L. concentrica*, Reuss, Denksch. Akad., Wien, Math. Nat. Klasse, VII, p. 107, pl. xvii, fig. 1.
1857. *eadem*, M.-Edwards and Haime, Hist. Nat. des Corall., II, p. 549.

Latim. corallum depressum, tenue, irregulariter expansum, infrâ radiatim striato-costellatum, supra undulatum; calycibus parvis, profundis, circ. tres mm. latis, plurimis in seriebus varie tortis sæpeque interruptis,—plerumque concentrice—dispositis ac confluentibus, jugis acutiuscule angulatis communis, calycum latitudine, separatis; septis numerosis, fere æqualibus, confertim granulatis, circiter tribus unius millimetri longitudinem occupantibus; columella parva, spongiosa.

An irregularly,– mostly in thin layers,– expanded species, with an undulating upper surface. The calyces are small and mostly united in variously twisted, often interrupted, and more or less concentrically arranged depressions of three or four mm. in width. The ridges which separate them are about equally broad and rather sharply angular. The septa are very numerous, three to one mm. distant, and finely granular. At irregular distances some of the ridges become occasionally much stronger.

M.-Edwards and Haime (loc. cit.) draw attention to the very close resemblance of the present species to *L. ataciana*; the former only appears to differ from the latter by the more or less pronounced concentric arrangement of the calicular valleys, and especially by thinner septa.

Both species have probably to be referred to *Mæandrastrea*, which belongs to the *FAVIDÆ*, a family placed by M.-Edwards intermediate between the *LYTHOPHYLLINÆ* and the *ASTREINÆ*.

Locality.—North-east of Odium, in a brownish limestone; rare.

Formation.—Ootatoor group, (upper beds).

Reuss described the species from the Gosau beds near Piesting in Lower Austria, and I have collected specimens of the same in the Edelbach-graben of the Gosau valley itself. One of the latter proved on comparison perfectly identical with the Indian fossil.

Family,—THAMNASTREIDÆ.

Prof. Reuss suggested[*] the separation of this family from the true *ASTREIDÆ*, particularly referring to it the two genera *Thamnastrea* and *Dimorphastrea.* Both have a compound corallum with extra calicular gemmation, but the calyces are confluent with their septo-costæ, and internally the septa are at regular distances connected by transverse lamellæ, which have a far greater resemblance to the synapticulæ of the *FUNGIDÆ*, than to the dissepiments of the *ASTREIDÆ*, and thus the present family may be regarded as a connecting link between the two last named ones.

Reuss adds (l. cit., p. 24,) a new genus *Pseudastrea*, with the type species *Ps. columnaris* from tertiary beds in Styria; and, I think, the genus *Comoseris*, which has very distinct synapticulæ, might be added. Fromentel appears to refer to the present family under the name '*Comosériniens*' on p. 159 of Pal. Franç. terr. cret., vol. viii, 1863.

I have to report from South India upon four species of *Thamnastrea*, one of *Dimorphastrea*, and one of *Comoseris*.

XIX. *Genus.*—THAMNASTREA, *Lesauvage*, 1823.

Hist. Nat. des Corall., vol. ii, p. 555.

Corallum very variable in form and size, globular, conoid, or with the upper surface flattened, or forming branched stems, on which the gemmation is submarginal. The calyces are superficial, connected in all directions with each other by their septal costæ; their centres are, however, distinct, with a more or less well developed columella; they are irregularly distributed over the entire surface. The septa and costæ are granulated laterally, and very variable in number.

The species are all fossil, extending from the mesozoic into the kainozoic epoch, though very much decreasing in number in the latter. There exists a remarkably great similarity between the different species, and as the size and form of the calyces often vary on different portions of one and the same corallum, the precise definition of the species is accompanied with no small amount of difficulty, or rather uncertainty. This may be gathered from the fact that the authors of the Hist. Nat. des Coralliaires relate about 30 doubtful species, which had in former years been established by themselves.

I have to notice from South India five species. Unfortunately the materials are such, that although the specific distinction cannot be questioned, I am unable to pronounce any of them as identical with formerly described species.

1. THAMNASTREA HIEROGLYPHICA, *Stoliczka*. Pl. VIII, Fig. 5.

Thamnast. corallum plus minusve regulariter orbiculare, supra fere planum, infra convexiusculum, calycibus numerosis irregulariter dispositis, impressis, versus peripheriam concentrice approximatis, 3 *ad* 5 *mm. latis, atque* 7 *ad* 10 *mm.*

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[*] Denksch. Akad., Wien, Math. Nat. Klasse, vol. xxiii, 1864, p. 23.

inter se distantibus; septis 24 ad 30 crassiusculis, in tribus cyclis dispositis, nonunquam cyclo quarto imperfecto; columella spongiosa; costis lateraliter dense granulatis, rectiusculis seu modice undulatis.

The corallum is largely orbicular, with an almost flat, upper, and a moderately convex lower surface. The calyces are quite irregularly distributed, only towards the periphery they become somewhat concentrically confluent. Each has a breadth of about 3 to 5 mm., and the centres of the adjoining ones are between 7-10 mm. distant, except when an interpolation of younger calyces takes place, in which case they are closer to each other. There are slight depressions to be observed between the calyces. One of the peculiarities of the present species is, that the septal costæ continue rather straight, or slightly undulating, from one calyx to the other. There are, as a rule, three complete cycles of septa, but sometimes their number rises to 30, so that a few septa of the fourth cycle begin to appear; generally only 12-15 of them extend to the columella, which is distinctly spongiose, somewhat elevated in the centre.

The species is closely allied to *Th. decipiens*, Mich., (*Th. confusa*, Reuss), but differs from it by the absence of the peculiar regularity in the costæ extending in a concentric direction from one calyx to the other, a character which always appears to be well marked in the European fossil.

Localities.—North-east of Kauray, in a brown limestone, and east of Parally, in a pinkish, conglomeratic and sandy limestone; not common.

Formation.—Ootatoor group.

2. THAMNASTREA BREVIPES, *Stoliczka*. Pl. IX, Figs. 2—3.

Thamnast. corallum agariciforme, supra convexiusculum, breviter pedicellatum, basi lata et irregulari sessile, epithecâ tenui indutum, infra epithecam tenuiter costellatum, costulis granuliferis; calycibus irregulariter dispositis, majoribus atque minoribus intermixtis, concaviusculis, sæpe subrotundatis, circiter 5 mm. latis; septis in tribus cyclis dispositis, cyclo tertio sæpe imperfecto, duodecim ad columellam spongiosam extensis, cæteris brevioribus; interspatiis calycum modice elevatis, costis nonunquam sub-obsoletis instructis; columella medio solidula, elevata.

A small, shortly pedunculated species, sessile by a broad irregular base. The epitheca is very thin, and the surface below it marked with granular rather thin, more or less confluent or branching ribs. The upper surface is convex; the calyces irregularly arranged, about 5 mm. in diameter, and from 3 to 8 mm. distant, measured from the centre of one calyx to the other. There are three cycles of septa present, but the third cycle is often incomplete, and generally only the older twelve septa extend to the columella; they appear to have their inner end somewhat thickened and confluent with the columella, which is central, solid, and moderately elevated. The costæ are thinner when crossing the elevated interspaces between the calyces, the mural mass being rather strongly developed.

Locality.—Ninnyoor, in a whitish limestone.

Formation.—Arrialoor group.

3. THAMNASTREA CRASSA, *Stoliczka.* Pl. IX, Fig. 4.

Thamnast. corallum crassum, irregulariter expansum, supra undulate planatum; calycibus irregulariter dispositis, 2 *ad* 3 *mm. latis, atque* 5 *ad* 7 *mm. distantibus; septis tenuibus, granulatis, lateraliter dense spinulatis, in tribus cyclis perfectis dispositis, iis ad primum atque secundum cyclum pertinentibus usque ad columellam spongiosam et parvam extensis, cæteris multo brevioribus.*

Only a fragment of the corallum of this species has been examined, and judging from this, the specimen appears to have been unusually large, undulately flattened above, convex below, and assuming a thickness of about 100 mm. The calyces are irregularly disposed, of small size, and connected by easily curved, thin, granular, costæ. The septa are usually disposed in three complete cycles; only rarely there are a few of a fourth cycle present; those of the first and second cycle extend to the columella, the others are shorter, and all are laterally densely spinulated. The septo-costæ are generally arranged in six radiating bundles.

Locality.—Odium, in brown earthy limestone.

Formation.—Ootatoor group.

4. THAMNASTREA PULLATA, *Stoliczka.* Pl. IX, Fig. 5.

Thamnast. corallum depressum, tenue irregulariter discoidale, supra plane convexiusculum, infra concaviusculum; calycibus irregulariter dispositis, 2·5 *ad* 3 *mm. latis, approximatis, septis distanter granulatis, in tribus cyclis dispositis, cyclo tertio sæpe imperfecto, costis brevibus, regione costali paulo elevata, theca murali satis distincta; columella spongiosa, medio sensim elevata.*

A small species, closely resembling *Th. tenuissima,*[*] Milne-Edwards and Haime, but the corallum is depressed, instead of globular, and the inter-calicular spaces are, like the columella, conspicuously elevated, while the calyces themselves are somewhat concave and comparatively rather wide, roundly polygonal. There are in both species three cycles of septa, but the third cycle is usually incomplete; all septa are rather coarsely granular, and only those of the two first cycles extend to the spongiose columella.

Locality.—East of Parally, in a coarse conglomeratic sandstone.

Formation.—Ootatoor group.

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[*] Comp. Bölsche in Geinitz's 'Elbethalgebirge in Sachsen,' 1871, p. 51, pl. 12, figs. 1—2.

5. THAMNASTREA INDUTA, *Stoliczka*. Pl. IX, Fig. 6, and Pl. X, Fig. 1.

Thamnast. corallum obverse conoideum, basi angustata aut latiuscula affixum, epithecâ crassa, concentrice distanter rugosa, in rugis atque prope marginem superiorem costis granuliferis notata, indutum, supra leviter convexiusculum; calycibus duobus, vel pluribus, paulo majoribus serie unica minorum plus minusve confluentium prope peripheriam sita circumdatis, theca costo-murali satis distincta separatis, paulisper concaviusculis, majoribus rotundate polygonis, 6 *ad* 7 *mm. latis, cum septis in quatuor cyclis dispositis, cyclo quarto imperfecto, alteris minoribus septis in duobus aut tribus cyclis dispositis, cyclo tertio imperfecto; septis omninis lateraliter crasse granulatis.*

This species is in some respects intermediate between *Dimorphastrea* and *Thamnastrea,* as there are some calyces enlarged in the centre, regularly surrounded by a series of smaller ones; the central ones have also a larger number of septa than the row of smaller ones, but on account of the greater number of central calyces, the species is, I think, more correctly referable to *Thamnastrea* than to *Dimorphastrea*. Whether this distribution is a merely accidental occurrence, cannot be for the present ascertained, because only two specimens exist in the collection, and these are not very perfectly preserved, except on the sections. The corallum was evidently sessile, with a tolerably broad base, and is covered with a well developed, thick epitheca, marked at some distances with concentric rugosities, on which, as well as near the upper edge, rather coarsely granular, equal ribs are to be observed. The septo-costal murail is well developed. The columella is distinctly papillose or spongiose in all calyces.

Locality.—Odium, in a brown earthy limestone; very rare.

Formation.—Ootatoor group.

XX. *Genus.*—DIMORPHASTREA, *d'Orbigny*, 1850.

Corallum of moderate size, compound, externally covered with an epitheca; calyces confluent, connected by a rudimentary costo-mural theca; the median one is the largest, the others arranged in more or less regular concentric series; costæ generally elongated and, like the septa, serrated, and laterally granular; columella spongiose or papillose.

The genus differs from the previous one simply by the arrangement of the calyces, of which a single central one is the largest.

Species of *Dimorphastrea* are at present only known from cretaceous and tertiary deposits; they are, however, much less numerous than the *Thamnastreæ*.

DIMORPHASTREA PATELLARIS, *Stoliczka*. Pl. X, Fig. 2.

Dimorphast. corallum late breviterque conoideum, epithecá crassula, sub-lævigata indutum, basi angustissima pedicellata affixum; superficie supera planiuscula; calyce magno centrali septis in quatuor cyclis perfectis dispositis instructo, septis ad primum atque secundum cyclum pertinentibus usque ad columellam extensis; calycibus minoribus in seriebus duobus concentricis sub-marginalibus dispositis, plus minusve distincter confluentibus, septis in tribus cyclis dispositis instructis; septis omninis tenuibus, granulatis, lateraliter crassiuscule spinulatis, theca costo-murali fere obsoleta; columella granulose minuteque papillosa.

The figured specimen is the only one examined. It is obversely shortly and broadly conoid, with a very narrow sub-pedicellate base for a place of attachment; the epitheca on the lower side is moderately thin, with few concentric swellings and some short ribs near the upper edge. The upper side is flattened, with a large calyx in the centre and two concentric rows of smaller ones along the periphery. The central calyx has four complete cycles of septa, and has a diameter of about 7 mm.; the other much smaller calyces generally possess only three cycles, sometimes there are a few septa of the fourth noticeable. The costæ are well developed, and, like their continuations, rather coarsely laterally spinulose, but the mural theca is almost entirely wanting. The columella consists of numerous thin, somewhat twisted columns.

Locality.—East of Poodoor, in a brownish, sandy limestone; apparently very rare.

Formation.—Ootatoor group.

XXI. *Genus.*—COMOSERIS, *Orbigny*, 1849.

Milne-Edwards & Haime, Hist. Nat. des Corall., iii, p. 62.

The coralla are composite, generally shortly sub-pedunculate and mostly irregularly expanded, below covered with an epitheca, above exhibiting numerous confluent calyces, with granulated and laterally strongly denticulated septa, and a rudimentary columella; they are separated by angularly elevated confused ridges.

Until a short time ago *Comoseris* was merely known from a few jurassic species. Recently two tertiary species, (*C. alternans* and *conferta*), were described by Prof. A. v. Reuss from Northern Italy. The discovery of a member of the genus in the cretaceous deposits of South India is, therefore, particularly interesting, because it proves its existence in the time intermediate between the two formations alluded to.

COMOSERIS OLDHAMIANA, *Stoliczka*. Pl. X, Fig. 3.

Comos. corallum breve, irregulariter sub-rotundate explanatum, supra convexiusculum, calycibus numerosis, parvis, plerumque uniserialibus, sed irregulariter dispositis, jugis modice elevatis, angulatis et irregulariter confluentibus separatis instructum; septis crassis, sub-æqualibus, granulatis, lateraliterque spinulatis, in tribus cyclis dispositis, cyclo tertio sæpissime imperfecto, omninis ad medium sensim attenuatis atque inter se plus minusve distincter confluentibus; columella parva sed distincter spongiosa.

This species has a remarkably close resemblance to the jurassic *C. irradians*, the corallum being irregularly ovately expanded, slightly convex above, and very shortly pedunculate below. The single specimen as yet known has scarcely any traces of the epitheca preserved; it is only indicated by irregularly concentric swellings, and the entire surface shows instead a radiating striation. The ridges on the upper side are rather sharply angular, moderately elevated, and quite irregularly but rather closely confluent. The calyces situated in the depressions are uniserial, small, with a small and distinctly spongiose columella. There are three cycles of septa, those of the last being very often incomplete, their total number varying from 18 to 24; they differ only slightly in strength and are rather coarsely granular. Both the calyces and ridges are almost equally numerously distributed over the entire upper surface.

Locality.—North-west of Moraviatoor, in a brown limestone; only the figured specimen has as yet been found.

Formation.—Ootatoor group.

Family,—CYCLOSERIDÆ.

Fromentel, Pal. Franç. terr. cret., viii, 1867, p. 323.

The CYCLOSERIDÆ include simple coralla, covered with an epitheca, the costæ on it being granular, branching and often anastomosing; the septa are numerous, thin, sub-equal, granular or dentate, and connected by synapticulæ.

Fromentel (l. cit., p. 325,) distinguished fourteen genera, out of which only two occur in South India, *Thecoseris* being represented by one and *Cyclolites* by four species.

XXII. *Genus.*—THECOSERIS, *Fromentel*, 1869.

Comp. Pal. Franç. terr. cret., 1870, tom. viii, p. 367.

Corallum more or less regularly turbinate, pedicellate, sessile, provided with a well developed epitheca; calyx flat or moderately convex, impressed in the centre; septa very numerous, equal or sub-equal, thin, serrated or dentated at their upper edges, sometimes anastomosing, meeting in the centre of the calyx without forming a columella.

This genus was recently established for certain liassic species, which, in external appearance, closely resemble *Leptophyllia*, but differ from it by the presence of a well marked epitheca, and by their synapticulæ. One species from South India appears to be referable to it. It is probable that some of the species without columella, described as aberrant forms of *Trochoseris*, will have to be referred to the present genus.

THECOSERIS AGARICINA, *Stoliczka*. Pl. XI, Fig. 1.

Thecos. corallum irregulariter agariciforme, breviter pedicellatum, calyce suprâ ovate elongatum, epithecâ concentrice rugoso-striata ; calyce plane convexiusculo, medio paulo impresso, septis tenuissimis, numerosissimis, æqualibus, acute denticulatis.

The short stem of the single specimen is only partially preserved, but on the lower side of the expanded portion the concentrically rugose epitheca is well developed. The calyx is of a somewhat irregular, elongately ovate shape, slightly convex above and impressed in the centre. There is no trace of a columella. The septa are very numerous, apparently almost equally thin throughout and finely denticulate at their upper edges; they all somewhat curve towards the periphery, and anastomose, a circumstance which is probably chiefly due to a slightly irregular growth of the corallum, and a somewhat unequal development of the epitheca.

Locality.—Near Odium, in a nodular earthy limestone; only the figured specimen has as yet been found.

Formation.—Ootatoor group.

XXIII. *Genus.*—CYCLOLITES, *Lamarck*, 1801.

Comp. Fromentel, Pal. Franç. terr. cret., tom. viii, p. 330.

Corallum circular, ovate or sub-ovate, upper surface hemispherical, or more or less flattened, septa very numerous, equal or unequal, radiating from a central groove or fossula, in which they meet somewhat irregularly, but do not form a separate columella; base flat or concave, with generally a thin, rarely thickened, mural sclerenchyma, covered by a concentrically folded epitheca.

This genus is as yet only known in a fossil state, and by far the largest number of species occurs in cretaceous deposits. Fromentel distinguishes a few groups of the genus, in order to facilitate the determination of the different forms; with the few species, which occur in South India before us, it is, however, not desirable to enlarge on this subject of detailed study.

Before noticing the four species presently to be described, I have to draw attention to a specimen of a *Cyclolites*, so thoroughly imbedded in a brownish limestone from near Ootatoor that it is impossible to extricate it from the rock. Judging from external shape and the distribution of the septa, the specimen appears to be very closely allied to *C. elliptica*, Lam., but better specimens are necessary to insure a good characteristic of the species, or its identification with one already known.

1. Cyclolites conoidea, *Stoliczka*. Pl. X, Figs. 4—5.

Cyc. corallum ovatum, conoideo elevatum, crassum, apice obtuse arcuato; fossula latiuscula, modice profunda, dimidium diametri majoris paulo superante; lateribus convexiuscule declivibus; septis numerosissimis, sub-granulatis, sub-æqualibus, septimo quoque septo plerumque fortiore; basi in juniore modice concava, in adulto fere plana, lævigata, concentrice distanter plicosa, medio paulo tumidula, peripheriam versus declivi atque radiatim striata, peripheria ipsa acute angulata.

Although merely known from the two specimens figured, these are sufficiently well preserved to characterize the species. It is somewhat allied to *Cyclolites conica* and *C. undulata*, but differs from both by the great length of the central groove or fossula, which is rather broad and comparatively shallow, descending on either side of the longitudinal axis. The sides are moderately convex. The septa close together, not very fine, and nearly equal; in most places each seventh or occasionally eighth septum appears to be somewhat thicker than the intermediate ones. The original edge of the septa has only partially been observed, but they all appear to be rather sharply, though not densely, granular. The base is concave in the smaller, nearly flat in the larger specimen, with a central thickened boss; the epitheca is thick, concentrically folded, and towards the periphery marked with radiating striæ. The peripherical edge itself is sharp.

Locality.—Near Valudayur; two specimens in a whitish sandstone.

Formation.—Arrialoor group.

2. Cyclolites pæcata, *Stoliczka*. Pl. X, Figs. 6—9.

Cycl. corallum ovatum vel rotundate ovatum, modice elevatum, lateribus convexiusculis; fossula centrali, satis profunda, in longitudine dimidium diametri majoris æquante; septis moderate crassis, numerosissimis, sat distanter granulatis, quoque quarto septo aut quinto alteris interpositis tenuioribus fortiori; basi concaviuscula, sub-lævigata, theca murali tenui, distanter concentrice sulcata, atque peripheriam versus radiatim striolata.

Diam. maj. speciminis maximi 24, diam. min. 21·5, alt. 8 mm.

The corallum is ovate or roundly ovate, with a nearly flat, but more generally somewhat concave base. The upper part is moderately elevated, with convex sides, and a centrally situated fossula, equaling in length half the longer diameter of the corallum. The septa are very numerous, and each fourth or fifth is stronger than the intermediate ones, which again differ in strength; they are all somewhat distantly and not strongly granular. The base is radiately striated towards the periphery.

This species bears a close resemblance to *C. spinosa*, Fromentel, (Pal. Franç. terr. cret., viii, p. 342, pl. 60, fig. 3), which differs from the Indian fossil by more densely spinulated septa and a much shorter fossula.

Localities.—Near Veraghoor[*] and Valudayur, in pale coloured sandstone; near Suderampet, in bluish sandstone; not uncommon.

Formation.—Arrialoor group.

3. CYCLOLITES FILAMENTOSA, *(Forbes)*. Pl. X, Figs. 10—12.

1846. *Fungia filamentosa*, Forbes, Trans. Geol. Soc., Lond., vii, p. 163, pl. xix, fig. 11.
1851. *Cycloseris* „ , Mil.-Edwards and Haime, Polyp. foss. terr. palæoz., p. 127, and Hist. Nat. des Coral., iii, p. 54.
1870. *Cyclolites filamentosa*, apud Fromentel, Pal. Franç. terr. cret., viii, p. 341, pl. 69, fig. 3.

Cycl. corallum circulare vel sub-rotundum, hemisphericum, lateribus valde convexis; fossula dimidio diametri breviore, modice profunda, centrali; septis numerosissimis atque exilissimis, septo quoque quinto vel sexto paulum fortiore, omninis acute granulatis lateraliterque spinulosis; basi sæpissime concava, rare fere plana, concentrice crasse plicata, theca murali solida et crassa, radiatim obsolete striolata.

Diam. speciminis maximi 23; alt. 11 mm.

This is a species with extremely thin septa, which on a well preserved surface scarcely vary in strength. This character combined with the shorter fossula, and a more regularly hemispherical shape, readily separates it from the previous species, in which also the mural theca at the base of the corallum is much thinner than it is in *filamentosa*, although this last is generally the smaller species.

Locality.—Near Valudayur, in a grey, fine-grained sandstone; apparently common.

Formation.—Arrialoor group.

4. CYCLOLITES ORBICULUS, *Stoliczka*. Pl. XI, Fig. 2.

Cycl. corallum orbiculare, parvum, supra convexiusculum, infra concaviusculum; fossula brevissima, sub-ovata, satis profunda; septis percrassis, circiter 56, fortioribus cum brevioribus atque tenuioribus alternantibus, distanter grosse sub-tuberculatis; basi concava, sub-lævigata.

The single specimen differs so essentially from other species of *Cyclolites*, that, although in a rather deficient state of preservation, it can hardly be confounded with any other known form. The solidity of the corallum and the unusual strength of the septa do not make it probable that the specimen is very young. The fossula is moderately concave, central, and somewhat ovate in shape. There are about 26 or 27 longer septa which originate in the fossula, and about as many shorter ones. In some places a third series of still thinner ones begins to appear, but its septa are, as a rule, not very distinctly traceable. The base is concave and appears to have been smooth.

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[*] Comp. Mem. Geol. Surv. of India, vol. iv, p. 136, where, in his report upon the geology of the Trichinopoly district, Mr. H. F. Blanford refers to this species under the name of *Fungia filamentosa*, Forbes.

An allied species was described by **Fromentel** (Pal. Franç. terr. cret., tom. viii, p. 359, pl. 63, fig. 3,) from the Gault or Upper Greensand deposits of Sainte Croix under the name of *C. Sanctæ-crucis;* it differs from the Indian form by having somewhat fewer and more equally strong septa, and a much smaller fossula, almost only represented by a central pit.

Locality.—Near Veraghoor, in a greyish sandstone.

Formation.—Arrialoor group.

MADREPORARIA PERFORATA.

Family,—MADREPORIDÆ.

Milne-Edwards and **Haime**, in their Hist. Nat. des Coralliaires, vol. iii, p. 99, divide the whole of the *Anthozoa* PERFORATA into two families, the *Madreporidæ* and the *Poritidæ*. The former is sub-divided in three sub-families, the *eupsamminæ*, without independent cœnenchyma, the *madreporinæ* and the *turbinarinæ*, with cœnenchyma, but the former has the septa unequally, the latter equally developed.

Sub-family.—EUPSAMMINÆ.

This sub-family includes, according to **Milne-Edwards** and **Haime**, simple and complex forms, the single coralla being without an epitheca; the septa are well developed and distributed in six systems, the septa of the third and subsequent orders are generally united by pairs, or in a greater number among themselves; the columella is spongiose or granular, and the walls are subcostulated, granulated, and perforated.

The *eupsamminæ* are represented in the South Indian cretaceous deposits by two species, apparently belonging to the typical genus *Eupsammia*, which has, I think, as yet only been known from tertiary deposits.

XXIV. *Genus.*—EUPSAMMIA, *Milne-Edwards* and *Haime*, 1848.

Corallum simple, sub-cylindrical or obconic, free, without any lateral mural expansion; calyx ovate or rounded, and of moderate depth; septa rather thin, laterally granular, generally irregular, in four or five cycles, sometimes with indications of a sixth one; columella well developed; costæ numerous, simple, extending the entire length of the corallum from the base, composed of fine but somewhat irregular granules.

M.-Edwards and Haime refer five species to *Eupsammia*, all from tertiary strata. The genus is very closely allied to *Balanophyllia*, differing from it by its free, often slightly umbilicated base, and also generally by the septa of the last few cycles being irregularly united to each other.

1. EUPSAMMIA VARIANS, *Stoliczka*. Pl. XI, Figs. 3—7.

1846. *Cladocora* sp. apud Forbes, Trans. Geol. Soc., Lond., vii, p. 163, pl. xix, fig. 10.

Eups. corallum obverse conoideum, cylindraceo elongatum, basi angustatum, modice arcuatum, in ætate adulta ad intervalla plus minusve fortiter atque irregulariter contractum; theca murali tenui, costis modice latiusculis, sulcis multo angustioribus separatis, simplicibus, vix undulatis, granulis irregularibus minutisque compositis; calyce satis profundo, rotundate ovato, ejusdem sectione ovata; septis tenuissimis, in quinque cyclis dispositis, iis ad primum atque secundum cyclum pertinentibus cæteris fortioribus et simplicibus, iis ad tertium, quartum ac quintum ordinem pertinentibus, in altitudine variabili prope columellam unitis, septis ad ordines sequentes pertinentibus multo tenuioribus atque subæqualibus, nonnunquam paulo irregularibus; columella lata, tenuiter spongiosa.

This is a very variable species as regards the shape of its corallum. A very young specimen (fig. 3) is regularly obversely conical, with a pointed free base, the calyx was moderately excavated and roundly ovate. Other specimens are more or less cylindrically elongated and at distances irregularly contracted, but all are curved, and none of them show any place of basal attachment. The mural theca is always thin. The costæ are nearly all equal, composed of fine granules and separated by much narrower furrows; they are almost straight. Of the larger specimens none showed the calyx exposed, and the septa are only traceable in a section of the stem. There are five cycles of septa; those of the first and second cycle are simple and somewhat thicker than the others, but, on the whole, all may be said to be thin, and they are laterally finely granulated. All the other septa are rather irregular and somewhat undulating. Those of the fourth and fifth order meet the third near the columella, but generally at different distances from it. The subsequent septa are sub-equal, and mostly unite with those of the fourth and fifth cycles, as well as with themselves, about half way between the columella and the peripherical edge. The width of the columella very nearly equals one-fourth of that of the entire corallum; it is very thinly spongiose.

Locality.—North of Odium, in a whitish calcareous sandstone; not common.

Formation.—Ootatoor group.

2. EUPSAMMIA DENOTATA, *Stoliczka*. Pl. XI, Figs. 8—9.

Eups. corallum inverse conoideum, basi attenuatum, lente curvatum, theca murali incrassata indutum, costatum, costis æqualibus, sulcis multo angustioribus separatis, simplicibus, sulco quoque circiter tribus seriebus granorum composito; septis tenuissimis, in sex cyclis dispositis, modice confluentibus, cyclo ultimo imperfecto; sectione coralli rotundate elliptica; columella tenuiter spongiosa, circiter quartam partem totius diametri lata.

I have only two rather imperfect specimens for examination, but they appear to belong to a well marked and distinct species. The form is reversely conoid with a roundly ovate section of the corallum, the perfect calyx has not been observed. The mural theca is of great thickness, and the costæ, each apparently composed of about three series of granules, which are comparatively broader than in ***Eups. varians.*** There are six cycles of septa present, but the last is incomplete; all are very thin, undulating, but not very irregular.

Locality.—North of Odium, in a yellowish limestone.

Formation.—Ootatoor group.

Family,—PORITIDÆ.

The members of this family are characterised by their compound coralla being entirely composed of a reticulated sclerenchyma; the single individuums are directly connected by a spongiose mural theca or a porose cœnenchyma, and are propagated by an extra-calicular gemmation; septa small, but otherwise well developed; visceral cavity with dissepiments, but never sub-divided by tabulæ.

Species of this family are found both fossil and recent. They are represented in South India by a single species, belonging to M.-Edwards and Haime's[*] sub-division *PORITINÆ*, in which the cœnenchyma is very slightly or not at all developed.

XXV. *Genus.*—COSCINARÆA, *Milne-Edwards* and *Haime*, 1848.

Massive coralla of a dense tissue and without an epitheca; calyces concave, with well developed septa and without pali, directly connected with each other by the septal costæ.

The type of this genus is *C. mæandrina*, Ehr., *(C. Bottæ*, M.-Edwards and Haime), a recent species from the Red Sea. The authors of the Hist. Nat. des Corall. (loc. cit.) also refer to the same genus Reuss' ***Porites mammillata***[†] from the Gosau deposits, and a very closely allied, if not the same, species also occurs in South India.

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[*] Hist. Nat. des Corall., iii, p. 173.

[†] Denksch. Akad., Wien, Math. Nat. Klasse, vii, 1854, p. 129, pl. x, figs. 9—10.

COSCINARÆA *conf.* MAMMILLATA, *Reuss.* Pl. XI, Fig. 10.

The only figured specimen which appears to be referable to the European species is a cast; the corallum is globose and sessile by a contracted base; the upper surface has some irregular impressions, and there is no trace of an epitheca. The calyces are somewhat concave, mostly one mm. wide, and directly connected by the serrated septal costæ; there are about 20 to 24 septa, of which, however, generally only eight reach to the centre, occupied by a thin columella. The figure represents a portion of the surface enlarged seven diameters.

I do not see any essential difference between the Indian and the Gosau fossil, but as the former is merely a cast, the determination is somewhat doubtful.

Locality.—Odium, in a brown limestone.

Formation.—Ootatoor group.

MADREPORARIA TABULATA.

(See p. 5).

Of the four (or perhaps three) families, distinguished in this sub-order by the authors of the Hist. Nat. des Corall. (vol. iii, p. 224), only that of the

Family,—MILLEPORIDÆ

is represented by a single species. The family is characterised by a large development of a cellular or tubular cœnenchyma.

XXVI. *Genus.*—HELIOPORA, *Blainville,* 1834.

Massive coralla of a shortly cæspitose, tuberose, or lobate shape, with largely developed, thinly tubular cœnenchyma, forming terminally fine pores on the surface, separated by somewhat raised papillose granules; calyces round; septa very short, but distinct; no columella.

The genus merely differs by its very short septa from *Polytremacis*, in which they reach to near the centre; it occurs both recent and fossil, but appears to be one of the rarest corals. M.-Edwards and Haime referred to it two species, *H. Partschi* and *macrostoma*, described as *Polytremacis* by Prof. Reuss from the Gosau deposits. Since then only very few species have been noticed from the kainozoic epoch. A single species occurs in the Cenomanien beds of South India.

HELIOPORA EDWARDSANA, *Stoliczka.* Pl. XI, Fig. 11.

Helip. corallum globosum, incrustans, in superficie irregulariter atque sparse tuberosum aut submammillatum; calycibus rotundis, unam mm. latis, in partibus elevatis approximatis, in interspaciis planiusculis aut concavis 4 *ad* 5 *mm. distantibus;*

septis octodecim subæqualibus, brevissimis; cœnenchymate confertim minuteque poroso, poris irregulariter dispositis, granulis papillosis separatis, circiter quintam partem unius mm. distantibus.

In its internal structure of the cœnenchyma and the eighteen very short septa, this cretaceous form is almost quite identical with the recent species, the type of the genus *H. cærulea*,* Grimm, but the calyces are considerably larger. The corallum has a few obtuse protuberances, on which the calyces are often very close together, while in the flattened or concave interspaces the distance between them increases to 4 and 5 mm.

Locality.—East of Kauray, in a brown limestone with coarse quartz-grains; only the figured specimen has been found.

Formation.—Ootatoor group.

GENERAL REMARKS DERIVED FROM THE EXAMINATION OF THE SOUTH INDIAN CRETACEOUS CORALS.

As I have already had occasion to observe in my introductory note, the examination of the corals from the cretaceous deposits in the Trichinopoly and South Arcot districts proved no less interesting than that of the other classes of animals, both in a zoological as well as geological point of view.

The conditions of the deposits were not so quiet that we could expect to find any of the Alcyonaria or of the Malacodermata preserved, but the Sclerodermata, or Madreporaria, are represented by fifty-seven species, namely, fifty-three belonging to the *APOROSA*, three to the *PERFORATA*, and one to the *TABULATA*. With the exception of a single new generic type, for which I proposed the name *Placastrea*, all the others belong to previously known genera, but the majority of the species are new.

Among the genera there are a few, like *Comoseris* or *Eupsammia*, which had not formerly been known to occur in cretaceous rocks; a few others, like *Platycyathus*, *Psammosmilia*, or *Stelloria*, belong to the rarest fossils, and some were previously only imperfectly known.

Looking at the whole fauna we see the reef-building *ASTREIDÆ*, *STYLINIDÆ*, and *THAMNASTREIDÆ* much exceeding the other families in numbers of species, as well as in frequency of occurrence of specimens. Coral reefs appear to have been of considerable extent, particularly along the old shores within the Ootatoor group; in the two other groups they were much more local. But still there are strong indications that these local faunæ have been much richer than I have been able to show from the comparatively scanty materials in our collection.

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* Comp. fig. 11 on pl. xxiv of vol. VII of Denksch. Akad., Wien, Math. Nat. Wissensch. Klasse, 1854.

The distribution of the species in the three divisions of the South Indian cretaceous deposits will be apparent by a glance at the accompanying table:—

No.	Name.	Page.	Plate.	Figure.	Locality and groups in India.		Geological position elsewhere.
	Sub-Order,—M. APOROSA.						
I	CARYOPHYLLIDÆ. ...	5					
1	Caryophyllia—	6					
1	„ *Arcotensis*, Stol. .	7	I	1-10	E. of Andoor ...	Arrialoor.	
2	„ *cupuliformis*, Stol. ...	8	I	13-15	Moraviatoor ...	Ootatoor.	
3	„ *granulifera*, Stol. ...	9	I	16-17	E. Odium, E. Kauray ...	Ditto.	
4	„ *gracilis*, Stol. ...	10	I	18	Ootatoor	Ditto.	
II	Trochocyathus—	10					
5	„ *affinis*, Stol. .	11	I	19	W. Kurribiem ...	Trichinopoly.	
III	Platycyathus—	11					
6	„ *indicus*, Stol. .	12	I	20	Odium	Ootatoor.	
II	TROCHOSMILIDÆ. ...	13					
IV	Trochosmilia—	13					
7	„ *brevicula*, Stol. ...	13	I	21	E. Parally	Ditto.	
8	„ *camura*, Stol. ...	14	I	22	Ditto	Ditto.	
9	„ *inflexa*, Reuss ...	15	II	1-4	Kolokure, Alundanapooram.	Trichinopoly ...	Turon beds of the Gosau, and France.
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20	„ *indica*, Stol. ...	25	V	1	Ninnyoor	Arrialoor.	
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22	„ *Reussiana*, Stol. ...	27	V	3-4	Odium, E. Kauray, Moraviat.	Ditto.	
23	„ *pumila*, Stol. ...	28	IV	7	Ninnyoor	Arrialoor.	
24	„ *decaphylla*, Mich. .	28	V	5-6	Alundanapooram, Ninnyoor.	Trichinopoly, Arrialoor	Turon beds in the Corbières in France, in the Gosau, and near Piesting in Austria.
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28	„ *ortica*, Stol.	31	VI	2	Odium	Ootatoor.	
29	„ *sp. indet.*	32	III	5	S. W. Penangoor	Ditto.	
30	„ *rotunda*, Stol.	32	VI	3	Moraviatoor	Ditto	Near *H. Simonyi*, from the Gosau.
XVI	PLACASTRAEA—	33					
31	„ *elegans*, Stol.	33	VII	1	Odium	Ditto.	
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34	„ *cyathina*, Stol.	35	VII	5-6	Kullay, Parally	Ditto.	
35	„ *morchella*, Reuss	36	VII	7-8	Alundampooram	Trichinopoly	Turon beds of the Gosau and near Piesting.
36	„ conf. *Hörnesi*, Reuss	37	VII	9	Moraviatoor	Ootatoor	*I. Hörnesi* was described from the Gosau deposits.
XVIII	LATIMAEANDRA—	37					
37	„ *obconica*, Stol.	38	VIII	1	Parally, Morav.	Ditto.	
38	„ *gyrina*, Stol.	38	VIII	2-3	Parally	Ditto.	
39	„ *crassa*, Stol.	39	VIII	4	Odium	Ditto.	
40	„ *interrupta*, Stol,	39	VIII	6	E. Parally	Ditto.	
41	„ *concentrica*, Reuss	40	IX	1	Odium	Ditto	Gosau valley and near Piesting.
V	THAMNASTREIDÆ.	41					
XIX	THAMNASTRAEA—	41					
42	„ *hieroglyphica*, Stol.	41	VIII	5	Kauray, Parally	Ootatoor.	
43	„ *brevipes*, Stol.	42	IX	2-3	Ninnyoor	Arrialoor.	
44	„ *crassa*, Stol.	43	IX	4	Odium	Ootatoor.	
45	„ *pullata*, Stol.	43	IX	5	Parally	Ditto.	
46	„ *induta*, Stol.	44	IX & X	6 & 1	Odium	Ditto.	
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It will be seen that out of the fifty-seven species forty-two are only known from the Ootatoor or lowest division, five from the Trichinopoly or middle, and nine from the Arrialoor or upper division, while a single species is common to the two last. The faunas are, therefore, as well defined as could be expected, and they indicate the soundness of the principles upon which the distinctions of these divisions have been based.

From our former researches we know that the Ootatoor beds are characterised as Cenomanien by ***Nautilus sub-lævigatus*, *Ammonites rostratus*** (vel ***inflatus***), ***Am. Rotomagensis*, *navicularis*** and ***Mantelli*, *Avellana elongata*, *Inoceramus labiatus*, *Exogyra sub-auriculata*** (vel ***columba***), ***Gryphæa vesiculosa*, *Terebratula depressa*,** and ***capillata*, *Cidaris vesiculosa*,** and many other fossils.

The Trichinopoly beds have a good number of characteristic Turonien fossils, such as ***Amm. peramplus*,** and ***A. Guadeloupæ*, *Turritella Neptuni*, *Pholadomya caudata*, *Eriphyla lenticularis*, *Modiola typica*, *Gryphæa diluviana*** and ***carinata*, *Rhynchonella compressa*,** etc.

The Arrialoor group, which represents the Senonien and Danien of d'**Orbigny**, is distinguished by ***Nautilus danicus*, *Amm. Ootacoodensis*, *Scala sub-turbinata*,** and ***striato-costata*, *Rissoina acuminata*, *Gryphæa vesicularis*, *pectinata*** and ***ungulata*, *Exogyra laciniata*, *Amusium membranaceum*, *Radula tecta*, *Inoceramus Crispii*, *Crania Ignabergensis*, *Cidaris sceptrifera*,** and many others of upper cretaceous type, as are, for instance, all the Ciliopoda (or Bryozoa), recorded in a former number of this volume.

When we look upon the coral fauna of the Ootatoor group, we meet with only one or two species identical with European forms, like ***Trochosmilia tuba*,** **From.**, and others not satisfactorily determined, which have certain affinities common with some species from the Gosau. The reason of this scantity in identification lies in the fact, that there are comparatively only few corals known from Cenomanien beds in Europe, and this fact makes, therefore, our Ootatoor coral fauna not only locally interesting, but geologically important for the study of this formation. The more striking is it when we find that out of the five species from the Trichinopoly beds no less than three, ***Trochosmilia inflexa*, *Astrocœnia decaphylla*,** and ***Isastrea morchella*,** occur in the Gosau and partly also in France, and in both localities the beds are referred to the Turonien. One of the species, ***Ast. decaphylla*,** which has in Europe a great geographical distribution in space, indicates this by its being common to the Trichinopoly and Arrialoor groups. From the last named group there are no other identical species with European forms, but we have actually not much to go upon in the identification of the species of this group, because the older publications on this subject are hopelessly insufficient.

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DESCRIPTION OF A SPECIES OF SPONGES AND ONE OF FORAMINIFERA FROM THE CRETACEOUS DEPOSITS OF SOUTH INDIA.

Sub-kingdom, AMORPHOZOA OR PROTOZOA.

This fifth large division of the animal kingdom is represented in the cretaceous deposits of the Trichinopoly district of Southern India merely by two determinable species, one Sponge and one Foraminifer. Both are fortunately referable to well known European fossils, *Siphonia piriformis*, Goldf., a very characteristic Cenomanien species, and *Orbitoides Faujasi*, Duj., an equally characteristic Senonien species. The former is found in our Ootatoor or lowest, the latter in the Arrialoor, or uppermost, division, thus admirably supporting the view which we have taken of the age of the cretaceous deposits of the Trichinopoly and South Arcot districts.

Class, SPONGIOZOA.

The study of this class* has, within the last few years, been greatly extended through the elaborate researches of Dr. J. E. Gray, Bowerbank, Kent, Eimer, Hæckel, O. Schmidt, and many others. The fossil species have been worked out by Goldfuss, Bronn, Geinitz, W. Dunker, Baron Rosen, etc. One of the most complete and most recent systems proposed is that of O. Schmidt, who divides the class into—

1.—*HEXACTINELLIDÆ*, in which the silicious spiculæ are formed after the tri-axial type.

2.—*HALISARCINÆ*, with the silicious spiculæ of uni-axial type.

3.—*LITHISIDÆ*, with a compound skeleton of apparently irregularly arranged spiculæ, in part probably calcareous, in part silicious.

4.—*CALCISPONGIÆ*, with a calcareous skeleton.

The only species observed in South India belongs to the

Group, *LITHISIDÆ*,

being a form of the

Genus—SIPHONIA, *Park.*, 1811.

It is characterised by a simple or geminal, globular, pyriform or even cylindrical body, with a central or sub-central cylindrical cavity at the upper end; from this cavity radiate in different directions thin canals, which terminate between small pores on the outer surface, the same having no epitheca; the specimens are generally sessile by a peduncle.

The *Siphoniæ* are chiefly known from cretaceous deposits.

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* Recently their relation to the Anthozoa and the Cœlenterata, generally, have been repeatedly pointed out.

SIPHONIA PIRIFORMIS, *Goldf.* Pl. XII, Figs. 1—2.

1826. Goldfuss, Petræf. Germ., I, p. 16, pl. vi, fig. 7.
1871. Geinitz, Elbthalgebirge in Sachsen, part I, Unterer Quader., p. 38, pl. 9, figs. 1—14.

One of the three specimens found in India is almost regularly pear-shaped, broadest near the upper end, which is depressedly convex; a few protuberances on the peduncle indicate that it had been ramified towards the base, somewhat as in Michelin's* figure of a specimen from Rouen. The circumference of the upper side is roundly ovate, and the width of the cavity is nearly one-fourth of the longer diameter. The canals on the upper side are, as usually, thin and anastomosing, disappearing towards the periphery. The openings at the outer surface are ovate, about one mm. long and from one-half to three quarter mm. broad; the finely porose interspaces generally being from one to one and a quarter mm., sometimes more, but transversely rarely exceeding two mm., while, when the surface is somewhat worn off, the openings of the canals become longitudinally confluent, forming more or less deep furrows.

The internal structure, as seen on a polished section, is quite irregularly interwoven, rather largely cellular and traversed by the larger canals, issuing from the axis.

Two other Indian specimens are shortly pedunculate, with a wide, irregularly rounded circumference near the upper convex surface. In one the width of the central cavity is about one-sixth, in the other only about one-eighth of the total diameter, which considerably exceeds the height of the specimen.

European specimens vary equally in form, as do those three found in India. Geinitz says, that they change from piriform to globular, pedunculated, or even to cylindrical shape, and that the base of the peduncle is either single or ramified.

I have compared European specimens with our fossil, and their structure agrees perfectly. If we had to go merely by Goldfuss' figures, his *Siphonia ficus*, from near Goslar, ought to be united with the present species, but in comparing actual specimens from that locality, the inter-canalicular texture appears to be finer and denser than in *piriformis*. It is, however, just possible that this difference merely consists in a somewhat different preservation of the specimens.

Locality.—North-east and north-west of Moraviatoor, in a brownish sandy limestone.

Formation.—Ootatoor group.

The species is, as already noticed, a characteristic fossil of the Cenomanien or *Rotomagensis* beds in Saxony (lower Quadermarl and lower Plæner), Bohemia, and almost throughout France. The closely allied (if not identical) English species, *S. Konigii*, from the chalk is considered as distinct on account of its very long peduncle, but this is not shown in Mantell's† original figure.

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* Iconograph, zoophyt., 1840—47, p. 137, pl. xxxiii, fig. 1.

† Geol. Sussex, p. 179, pl. xvi, figs. 19, 20, 21.

Class, RHIZOPODA OR FORAMINIFERA.

Like the Sponges the Rhyzopods are a mere organic fluid or viscose mass, without any special or permanent organs, but their little shells, simple or chambered, compete in regularity, exactness of proportion, beauty of form and of ornamentation with almost anything else we know in the animal kingdom. The names of Ehrenberg, Schultze, Dujardin, Carpenter, and many others will for ever remain connected with the study of this class. For the fossil forms no one has greater merit than A. d'Orbigny and Prof. A. E. von Reuss; the latter author having in 1861 published* an elaborate Prodromus towards a natural system of the Foraminifera, particularly with reference to the fossil forms, of which no other naturalist has examined a larger number.

Prof. v. Reuss divides the entire class into two large divisions, according to the shell being porous or not. Of the next importance is considered the calcareous or silicious structure, etc.

Our species belongs to the group with a porous shell, which is traversed by a complicated system of canals.

Besides this single determinable species, I have only observed a few very imperfect specimens of a *Rotalia* from the marly limestone of Chokanadapooram and one small, smooth *Lagena* from the sandy beds at Yermanoor, both belonging to the Arrialoor group.

Family,—NUMMULITIDÆ.

Reuss, l. cit., p. 389.

Genus.—ORBITOIDES, *d'Orbigny*, 1847.

Shell discoid or lenticular, with sharpened margins, composed of a central simple layer of spirally or concentrically arranged cells, connected by canals with each other, and superposed on both sides by several other layers of cells; outer surface more or less rough, granular, or tubercular and porous.

The species of the genus are found from the cretaceous epoch up to the present time.

ORBITOIDES FAUJASI, *(Defrance)*. Pl. XII, Figs. 3—5.

Reuss in Sitzungsb. Akad., Wien, Math. Nat. Klasse, 1861, vol. xliv, pt. i, p. 309, (cum syn.).

Shell discoid, varying from four to eight mm. in diameter, and one to three in thickness, sharpened at the periphery, sometimes irregularly bent; on both sides equally convex, or nearly flat on one of them, sometimes with a prominent central boss. Surface more or less distinctly granular and sub-tubercular, finely porose. The chambers in the middle layer are concentrically arranged round a large nuclear cell; they are anastomosting with neighbouring chambers in the same series as well as with those belonging to the previous and subsequent circles; these chambers are squarish on the section, and their thickness varies from one-fifth to one-tenth of the total thickness. The cells in the superimposed layers are considerably smaller, depressed; on a vertical section their ranges are perpendicular, or very nearly so, to the horizontal central layer, and their number varies from four to twelve; generally they are not equally numerous on the two sides.

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* Sitz. Ak., Wien, Math. Nat. Klasse, xliv, pt. i, p. 355. Scarcely a volume of either Sitzungsberichte or Denkschriften of the Academy is published without some valuable contribution to the fossils of this class.

Prof. Reuss, who has described the internal structure of this species in great detail, has not been able to observe the communication of the cells belonging to the same concentric series. This connection is very clearly seen on two sections made of Indian specimens, and I have also observed it on two other sections of Maastricht specimens; it is exactly the same as observed by Carpenter in tertiary species of the genus. (Comp. Quart. Jour. Geol. Soc., Lond., 1850, vol. vi, p. 32, etc.).

Localities.—Ninnyoor, in white limestone; Chokanadapooram, in a pinkish earthy limestone.

Formation.—Arrialoor group.

Orb. Faujasi is one of the most common Foraminifers in the Senonien beds at Maastricht; it has also been found on the island Rügen, at Aachen, and various other places of Germany and France (Royan, Lanquais, etc.).

NOTE ON THE ARTHROZOA AND SPONDYLOZOA, REPRESENTED IN THE SOUTH INDIAN CRETACEOUS DEPOSITS.

These two sub-kingdoms are so very scantily represented in our collection that it is scarcely worth while to enter into any particular details on the subject. However, in order to complete the account of the fossils which have as yet been found in these deposits, I shall briefly notice those species which have been described from Messrs. **Kaye** and **Cunliffe's** collection, adding to these a few others of which specimens have been procured during the course of the survey.

VERMES.

If we exclude a few doubtful tubes which are to all appearance referable to the *PHOLADACEA*, and others which belong to the *VERMETIDÆ*, there are four species of *Serpula* and one of *Ditrupa* represented. The specific determination of these tubes is often very unsatisfactory, and though our materials are comparatively not very large, they admit of a tolerably good definition of at least three different forms.

1. SERPULA FILIFORMIS, *Sow.* Pl. XII, Fig. 6.

Sowerby, Trans. Geol. Soc., Lond., iv, p. 340, pl. 16, fig. 2.
Reuss, Böhm. Kreide., pt. i, p. 20.
S. socialis, in part, **Goldfuss**, Petræf. Germ., pl. 69, fig. 12.

The tubes are round, smooth, generally half a millimeter thick, rarely increasing to one mm., growing socially in large masses, composed of variously twisted bundles of about 15 to 30 tubes in each.

The Indian form exactly agrees with the European one in the form and thickness of tubes and manner of growth; it can, I think, be fairly considered as identical with it. It was first well figured by **Goldfuss** as *S. socialis*, under which name he included forms from devonien, jurassic, and cretaceous beds. **Sowerby** proposed to restrict **Goldfuss'** name to the jurassic form, and named the upper Greensand one from Blackdown *S. filiformis*. It occurs almost throughout the upper cretaceous beds (Upper Greensand and Chalk, Cenomanien, Turonien, and Senonien, Quadersanstein and Plæner) of England, France, Germany and Austria (Bohemia, Galizia, and the Banat).

Locality.—Arrialoor, in light grey sandstone.

Formation.—Arrialoor group.

2. SERPULA *conf.* GORDIALIS, *Schlotheim.* Pl. XII, Figs. 7—8.

Comp. Goldf. Petræf. Germ., p. 241, pl. 71, fig. 4.

Tubes round, smooth, varying in thickness from one to one and a half millimeter, growing in short bundles, or in more compact masses variously entangled between each other, or more solitary, creeping on shells and other substances.

The Indian species does not appear to exhibit any perceptible difference from the European one above referred to, but I have no specimens for comparison, and do not wish, therefore, to pronounce their absolute identity, because the mode of growth somewhat differs from the form figured by Goldfuss, although Schlotheim refers to compact masses.

It is probable that Sowerby's *S. plexus* from the Chalk also belongs to this species (Comp. Min. Conch., vi, p. 201, pl. 598, fig. 1); it certainly is not identical with *filiformis*, as suggested by Reuss (Böhm. Kreide, pt. i, p. 20).

Localities.—Arrialoor, in grey sandstone; south of Mulloor, in whitish or yellowish sandstone.

Formation.—Arrialoor group.

S. gordialis is an extremely common species in the Upper Plæner and Maastricht beds, all through Germany, Northern Austria, and France.

3. SERPULA OOTATOORENSIS, *Stoliczka.* Pl. XII, Figs. 9—10.

Tubes simple, moderately bent, six to seven mm. thick, round, somewhat transversely rugosely striated; the thickness of the solid test is one to one and a third mm. The one end is occasionally thickened by a circular swelling. The tubes resemble those which in the Plæner of Bohemia and Saxony are often quoted as *Serpula amphisbæna*, Goldf., and some of which no doubt belong to the SERPULIDÆ, while others are referable to *Gastrochæna* and *Teredo.* They are of almost equal thickness throughout.

Locality.—Ootatoor and west of Odium, in earthy limestone; the species does not appear to be rare; several specimens are in the collection.

Formation.—Ootatoor group.

4 SERPULA ? HAMATA, *Forbes.* Pl. XII, Fig. 11.

Dentalium ? hamatum, Forbes, Trans. Geol. Soc., Lond., vii, p. 138, pl. xv, fig. 8.

Of this species, of which no specimen exists in our collection, I have already observed (in Vol. II of the Pal. Indica, p. 444,) that the description and figure of the species are based upon a longitudinally ribbed *Serpula.* Forbes' original is taken from a fragment imbedded in a calcareous sandstone, which is wholly perforated with these annelide tubes; their shells are thick; externally they appear to have four longitudinal somewhat distant ribs on one-half of the circuit, five somewhat closer on the other. The external layer of the shell is more compact than the inner, which breaks off in thin lamellæ. On the section the longitudinal ribs are perfectly clearly traceable, but the shell is so thoroughly attached to the rock that it always leaves only the cast visible as soon as an attempt is made to remove it.

I can only add an approximate figure of the outer side and of the section.

5. DITRUPA? LONGISSIMA, *Forbes.* Pl. XII, Fig. 12.

Trans. Geol. Soc., Lond., vii, p. 157, pl. xix, fig. 13.

'*D. testa cylindrica, longissima, concentrice regulariter striata, striis minutissimis,* '*(nucleo lævi).*'

'Length of specimen 4½ inches, diameter 0⅛ inch.

'A very long, regularly curved, cylindrical shell. The surface is marked with 'very minute concentric striæ. The cast is smooth. The habit is so truly that 'of a testaceous tubicular *Annelide*, and the regularity of form so similar to the 'aspect of a *Ditrupa*, that, although the mouth is not preserved, I have little hesitation in referring it to that well-marked genus.

'It is contained in a mass of rock from Pondicherry, and is associated with '*Baculites*, and various univalve and bivalve shells.'

Such is Forbes' account of this species. From the last reference to *Baculites*, it appears most probable that the beds referred to belong to the Arrialoor group. There is no specimen of it in our collection.

CRUSTACEA.

Prof. Forbes gave a figure of the carapace of a crab from Pondicherry out of Mr. Kaye's collection. A second specimen was presented by Mr. Cunliffe to our Museum, but it is, like the former, incomplete. Very probably it belongs to some species of a *Neocarcinus.* I give figures of both on pl. xii, figs. 13 and 14. Our specimen is either from the Arrialoor beds at Pondicherry, or, judging from the occurrence of *Turritella affinis*, Stol., with our specimen, it may also be from the Veraghoor sandstone of the Trichinopoly group.

A second specimen of a Crustacean is from the Ootatoor shales at Ootatoor; it is the left hand of an *Hoploparia*, or some other closely allied genus. A figure of this fragment is also given on pl. xii, fig. 15.

The only other Crustacean which I saw was a small *Cytherina* from the yellow Arrialoor sandstones at Yermanoor, occurring together with *Stygmatopygus elatus*, (Forbes).

PISCES.

Sir Philip J. Egerton described in vol. I of the Quart. Journ. Geol. Soc., London, (reproduced in Trans. Geol. Soc., vol. vii, p. 89 et seq.), the following species:—

Enchodus serratus, Eg.; *Sphærodus rugulosus*, Eg.; *Corax pristodontus*, Agassiz; *C. incisus*, Eg.; *Otodus? marginatus*, Eg.; *O. basalis*, Eg.; *O. nanus*, Eg.; *O. divergens*, Eg.; *O. minutus*, Eg.; *Oxyrhina triangularis*, Eg.; *Lamna complanata*, Eg.; *L. sigmoides*, Eg.; *Odontapsis constrictus*, Eg.; *O. oxyprion*, Eg.

I shall very briefly notice these in a somewhat similar order, adding a few more species. I do not need to repeat the great uncertainty in the determination of these stray relics, and will, therefore, not attempt to characterize the genera.

1. PTYCHODUS LATISSIMUS, *Ag.* Pl. XII, Fig. 16.

Agassiz, Poiss. foss., vol. iii, pl. 25a and 25b, figs. 24-26; idem, Geinitz, Reuss, Mantell, et auctorum.

A single tooth in the collection exactly agrees in the general squarish form, moderate convexity, and in the thickness of the enamel bands with the European species; the sharp edges of these enamel bands are very minutely crenulated, as is usually the case in this and most other species of the genus. The exact locality of the specimen is not recorded, but it was together with a small fish bone of quite similar preservation, and this leaves but very little doubt that both are from east of Olapaudy in the Arrialoor group.

In Europe *Pt. latissimus* is one of the most common species of the middle and upper cretaceous beds, Upper Greensand and Chalk.

2. SPHÆRODUS RUGULOSUS, *Eg.* Pl. XII, Fig. 17.

Sir Philip Egerton figures (Quart. Journ. Geol. Soc., Lond., 167,) a few *Sphærodus* teeth, which, he says, are distinguished from other allied 'forms by the wrinkled or shrivelled appearance of the superficies.' The specimens are from Pondicherry.

3. PYCNODUS? *sp.* Pl. XII, Fig. 18.

A single fragment of a jaw from the *Ootatoor beds* east of *Ootatoor* is in our collection. It has a single series of four teeth, the last being very small; the penultimate is largest, longer than broad, sloping posteriorly; the two following are shorter than broad and squarish, depressedly convex above. The specimen evidently belongs to some *Pycnodonte* fish.

4. CORAX PRISTODONTUS, *Ag.* Pl. XII, Fig. 19.

Egerton (l. cit., p. 167,) says that a fragment exactly corresponds with specimens from the Maastricht beds.

5. CORAX INCISUS, *Eg.* Pl. XII, Fig. 20.

Compare **Egerton**, l. cit., p. 168.

Neither of the two last species is represented in our collection.

6. OTODUS MARGINATUS, *Eg.* Pl. XII, Fig. 21.

Egerton, l. cit., p. 168.

Egerton says that the tooth which he refers to the above species has a narrower cone than most specimens of *O. appendiculatus*, and that the inner surface is more arched than in any other known species. The cutting edge is sharp, and so distinct as to have the appearance of a border, separated from the remainder of the shaft by a shallow groove.

7. OTODUS BASALIS, *Eg.* Pl. XII, Figs. 22 & 23.

Egerton, l. cit., p. 168.

Differs from the former and from *O. appendiculatus* by the great size of the lateral cusps and the comparatively small size of the middle cone. We have a specimen of this species from east of *Ootatoor* in the *Ootatoor group*.

8. OTODUS *conf.* SEMIPLICATUS, *Münst.* Pl. XII, Fig. 24.

Agassiz, Poiss. foss., vol. iii, p. 272, pl. xxxvi, figs. 32, ? 33; **Reuss**, Böhm. Kreidef., pt. I, p. 5.

A single specimen of a tooth from the sandstone beds north of *Kunnanore*, in the *Arrialoor group*, is very closely allied to the above-named species, except in having a more slender cone, but as the form of this varies in different places of the same jaw, that point does not invalidate the probable identity of our fossil with the European one. The width of the base considerably exceeds the height of the middle cone, and is on both sides along the margin longitudinally plicated. The edges are undulately serrated as soon as they descend from the cone, and the lateral cusps are of moderate size and rather distant. All these characters perfectly agree with the European fossil, which occurs in the Plæner of Saxony and of Bohemia.

9. OTODUS NANUS, *Eg.* Pl. XII, Figs. 25—28.

Egerton, l. cit., p. 169.

In addition to Egerton's figure, I give representations of two specimens from *Ootatoor* and of one from *Odium*. All these three differ from the typical form by a larger size, but all agree in general form, proportion of width and thickness, etc. The specimen from Odium is nearly straight, and on one side shows the origin of a small lateral cusp.

10. OTODUS MINUTUS, *Eg.* Pl. XII, Figs. 29—30.

Egerton, l. cit., p. 169.

This is very closely allied to the last, but somewhat more slender and with proportionately larger cusps. It occurs both at *Pondicherry* and in the sandstones east of *Ootatoor* in the *Ootatoor beds*. The larger teeth are very like those of *Lamna complanata*, but are convex on both sides.

11. OTODUS DIVERGENS, *Eg.* Pl. XII, Fig. 31.

Egerton, l. cit., p. 169.

The peculiarity of this species is said to rest in the great development of the lateral cusps and in their position close to the cone. The specimen from Mr. Kaye's collection is as yet unique.

12. OXYRHINA TRIANGULARIS, *Eg.* Pl. XII, Figs. 32—33.

Egerton, l. cit., p. 169.

The cones do not appear to differ in the least from those of *Otodus nanus*, but are said to have no lateral cusps, and are, therefore, referred to *Oxyrhina*.

13. OXYRHINA (MERISTODON), *sp.* Pl. XII, Fig. 34.

Our collection contains a single tooth from *Olapaudy* in the *Arrialoor group;* it does not appear to have any trace of lateral cusps. The inner surface is somewhat more convex than the outer one, and both are longitudinally plicated, the ribs being very much thinner than the interspaces separating them, and they disappear towards the end of the cone. The edges are rather sharp and slightly crenulated. The whole tooth is very much of the type of the English *Oxyrhina paradoxa*, Ag.

14. ODONTAPSIS CONSTRICTUS, *Eg.* Pl. XII, Figs. 35—37.

Egerton, l. cit., p. 171.

This species is common both at *Pondicherry* and *east of Ootatoor* in the *Ootatoor group*. In one specimen from the latter locality, I have been able to trace on one side a very small lateral cusp; it is situated very much posteriorly and low down.

As regards the shape of the cone itself, the Indian specimens are perfectly identical with some of those described by Reuss as *Oxyrhina angustidens* from Bohemia (Comp. Reuss, Bœhm. Kreidef., pt. i, p. 6, pl. iii, figs. 7—9). Both of them show the small depression at the centre of the outer basal margin of the cone.

15. LAMNA COMPLANATA, *Eg.* Pl. XII, Fig. 38.

16. LAMNA SIGMOIDES, *Eg.* Pl. XII, Fig. 39.

The peculiarities of these species may be seen from the accompanying figures. As no specimens exist in our collection, I have nothing to add to Egerton's notice.

17. ODONTAPSIS OXYPRION, *Eg.* Pl. XII, Fig. 40.

This is distinguished from *O. rhaphiodon* by the large lateral cusps being more elongated and sharper at the points.

18. ENCHODUS SERRATUS, *Eg.* Pl. XII, Fig. 41.

Egerton, l. cit., p. 166.

Egerton, when examining three specimens of an *Enchodus* from Mr. Kaye's collection, says that they differ from those of *E. halocyon*, Ag., by the surface of the enamel being more smooth and even, in consequence of the fineness of the longitudinal striæ, which in *halocyon* are coarser and strongly marked. The transverse bands are said to be broader and the form of the teeth less attenuated. The chief difference rests in the finely serrated cutting edge, which in *halocyon* is said to be smooth and entire. No figure is given of any of the specimens, all three being said to be imperfect.

Our collection possesses a single tooth from the neighbourhood of *Karapaudy* in the *Arrialoor group*. It undoubtedly very closely resembles that of *E. halocyon*, particularly the figures given by Geinitz in Charact. etc., pt. iii, p. 63, pl. xvii, figs. 13-14, but the longitudinal striation is finer, disappearing towards the pointed end and also towards the lateral margins. The enamel is, however, in our specimen unfortunately so much weathered off that no serration can be traced at the edges. The tooth is nearly an inch long.

SAURIA.

In his report on the geology of the Trichinopoly District (Mem. Geol. Surv., India, vol. iv, p. 139), Mr. H. F. Blanford mentions the occurrence of a *Megalosaurus* tooth together with some bones in the *Arrialoor beds* at *Cullmoad.* I have seen some fragments of these bones; they are, as Mr. Blanford remarks, so very fragile and imperfect that no reliable determination can be made, and unfortunately the solitary fragment of the tooth is not at present accessible, so that I am unable to add anything to the information given by Mr. Blanford.

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PLATE I.

Figs. 1—10. CARYOPHYLLIA ARCOTENSIS, *Stol.*, p. 7; 1 to 6 and 10, side views of different specimens; 6*a*, view of the calyx, twice the natural size; 7 and 8, longitudinal sections; 9*a*, small specimen with the calyx weathered out, twice the natural size; 10*a*, view of a section, twice the natural size; the black lines mark the septa; *E. of Andoor, Arrialoor group.*

Figs. 11—12. TURBINOLIA ARCOTENSIS, *Forbes*, p. 8; copies of Forbes' original figures.

Figs. 13—15. CARYOPHYLLIA CUPULIFORMIS, *Stol.*, p. 8; 13, side view; 13*a*, section, twice the natural size; 14, 14*a*, side and top views, twice the natural size; 15 and 15*a*, same views of another specimen, natural size; in 13*a* and 15*a* the black lines mark the septa and pali; *Moraviatoor, Ootatoor group.*

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Fig. ... 20. PLATYCYATHUS INDICUS, *Stol.*, p. 12; 20, 20*a*, 20*b*, 20*c*, side-, lower, sectional, and top views in natural size; 20*d*, a portion of the calyx enlarged; *Odium, Ootatoor group.*

Fig. ... 21. TROCHOSMILIA BREVICULA, *Stol.*, p. 13; 21, side view; 21*a*, a section from very close to the calyx; the black lines indicate the septa; 21*b*, a small portion of the outer surface enlarged; *Parally, Ootatoor group.*

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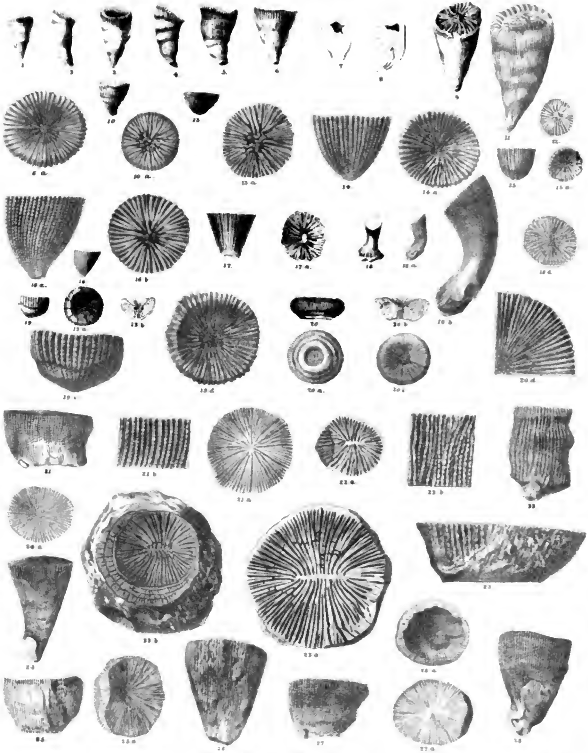

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PLATE II.

Figs. 1—4. TROCHOSMILIA INFLEXA, *Reuss*, p. 15; 1, 1*a*, 1*b*, two side views and a section of a large corallum, Koloture; 2 and 3, polished sections; 4, a worn specimen, side view; *Alundanapooram, Trichinopoly group.*

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Figs. 10—11. PSAMMOSMILIA ORIENTALIS, *Stol.*, p. 19; 10*a*, very short corallum, only round the calyx weathered out of a limestone rock; 11, side view of a more elongated specimen; *Cooticaud, Ootatoor group.*

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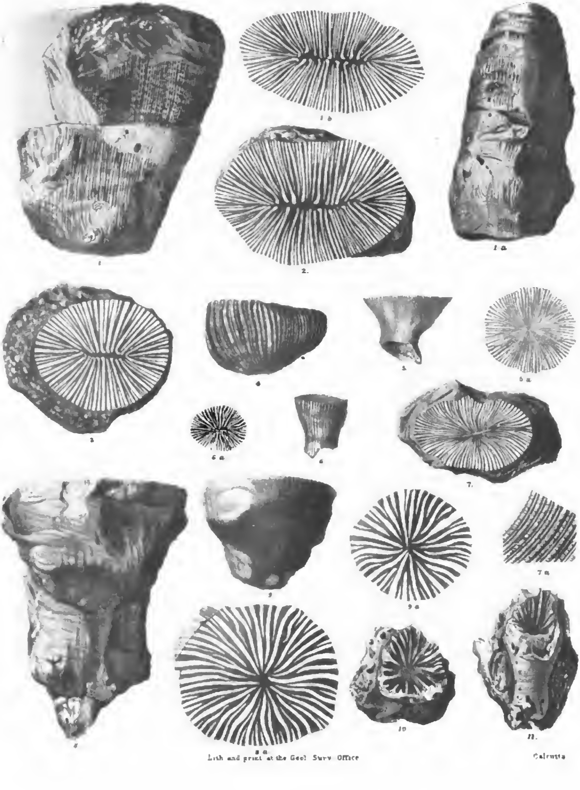

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PLATE III.

Figs. 1—2. STYLINA MULTISTELLA, *Stol.*, p. 20; 1, upper view of a large convex corallum; 1*a*, a few calyces in twice the natural size; 2, portion of a flat corallum, with the surface much weathered off; 2*a*, a polished section; *Morariatoor, Ootatoor group.*

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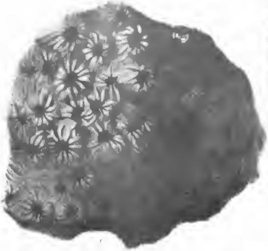

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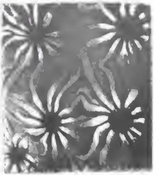

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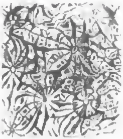

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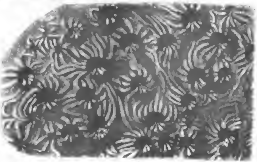

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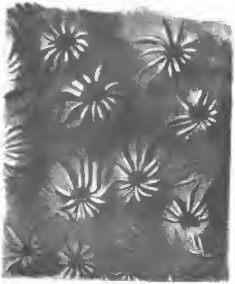

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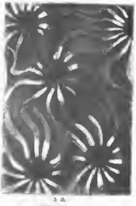

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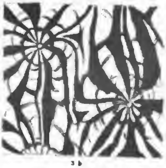

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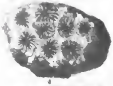

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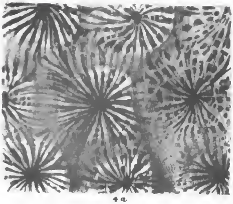

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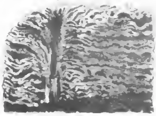

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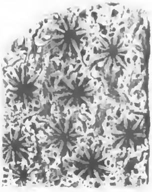

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PLATE IV.

Figs. 1—3. **Thecosmilia geminata**, *Stol.*, p. 23; 1, 1*a*, upper and side views of a large specimen, with only a small portion of a second individuum preserved; 2, a young bi-geminate corallum; 2*a*, side view of the same; 3, upper view of another corallum composed of three individuums; *Moraviatoor, Ootatoor group.*

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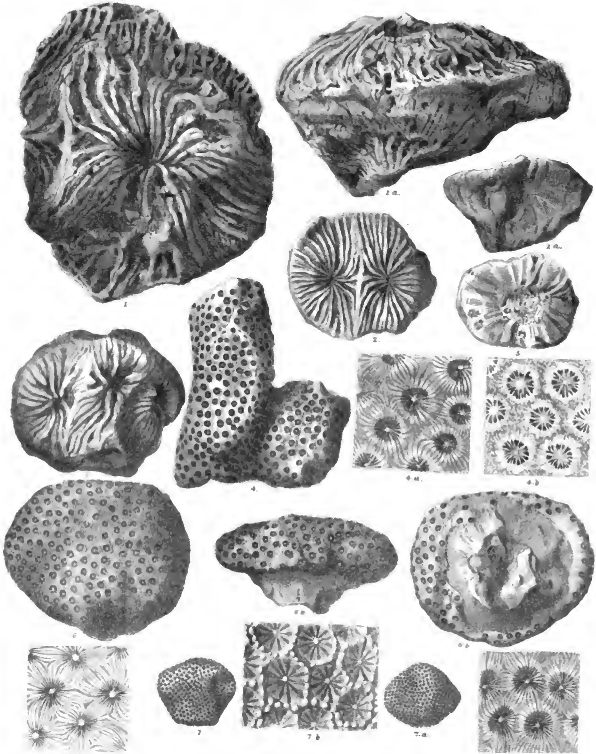

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PLATE V.

Fig. ... 1. Holocœnia indica, *Stol.*, p. 25; 1, upper view of the corallum; 1*a*, a portion of the original surface; 1*b*, a similar one of the polished surface, enlarged; *Ninnyoor, Arrialoor group.*

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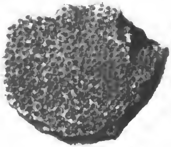
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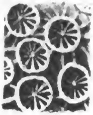
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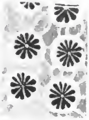
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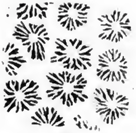
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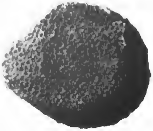
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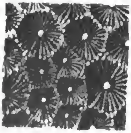
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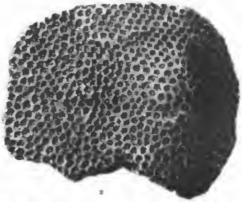
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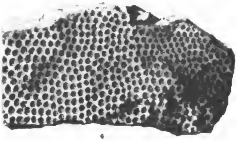
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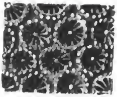
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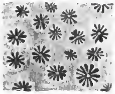
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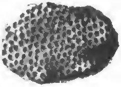
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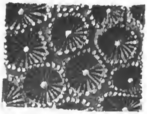
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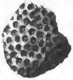
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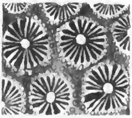
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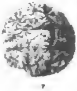
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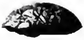
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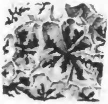
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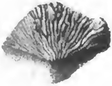
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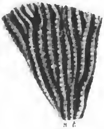
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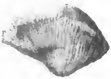
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S. Sedgfield lith.

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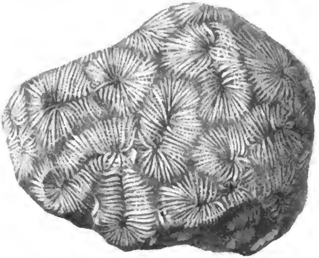
PLATE VI.

Fig. ... 1. MYCETOPHYLLIA NOBILIS, *Stol.*, p. 29; 1 and 1*a*, upper view, and portion of the side view of a large corallum; *N. of Alundanapooram, Trichinopoly group.*

Fig. ... 2. HELIASTREA ORTIVA, *Stol.*, p. 31; 2, upper view of a corallum; near the right end the original surface is preserved, about the middle the surface is weathered off, and at the left end it is polished; 2*b*, enlarged original surface; 2*c*, weathered surface; 2*d*, polished surface; 2*e*, side view of a portion of the corallum; *Odium, Ootatoor group.*

Fig. .. 3. HELIASTREA ROTUNDA, *Stol.*, p. 32; 3, upper view of the corallum, natural size; 3*a*, original, 3*b*, polished surface; *Moraviatoor, Ootatoor group.*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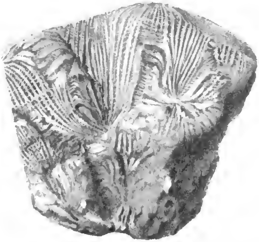
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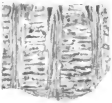
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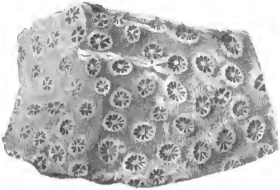
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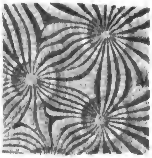
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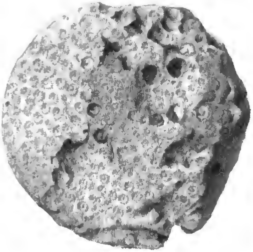
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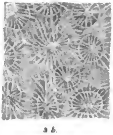
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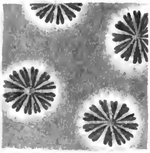
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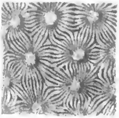
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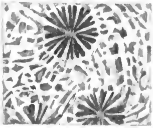
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PLATE VII.

Fig. .. 1. Placastrea elegans, *Stol.*, p. 33; a portion of the original corallum in natural size, and a few calyces enlarged; *Odium, Ootatoor group.*

Fig. 2. Isastrea expansa, *Stol.*, p. 34; similar figures as of the last species; *Odium, Ootatoor group.*

Figs. .. 3—4. Isastrea Siva, *Stol.*, p. 35; 3 and 4, upper views of two different specimens in natural size; 3*a*, a small portion of the surface enlarged; *N. E. of Moraviatoor, Ootatoor group.*

Figs. 5—6. Isastrea cyathina, *Stol.*, p. 35; 5, 5*a*, side and upper views in natural size; 5 *b*, upper view, enlarged twice the natural size; *Parally*; 6 and 6*a*, side and upper views in natural size of a specimen from *Kullay; Ootatoor group.*

Figs. 7—8. Isastrea morchella, *Reuss*, p. 36; 7, 7*a*, side and upper views of a large, pedicellate specimen; 8, 8*a* and 8*b*, upper, side and lower views of a very much depressed, almost discoid specimen; *N. of Alundanapooram, Trichinopoly group.*

Fig. .. 9. Isastrea (*conf.*) Hörnesi, *Reuss*, p. 37; side and upper views of a specimen with polished upper surface; *Moraviatoor, Ootatoor group.*

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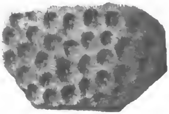
Corals *Pl. VII.*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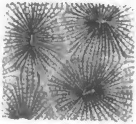
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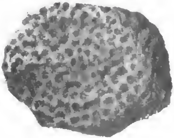
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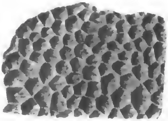
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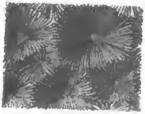
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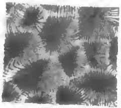
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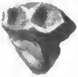
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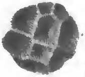
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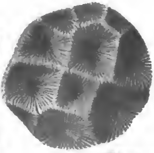
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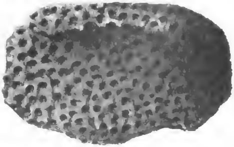
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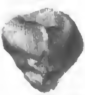
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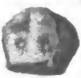
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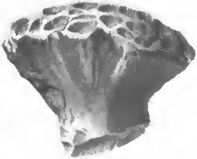
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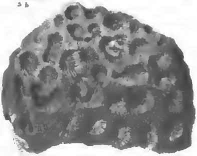
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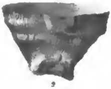
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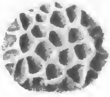
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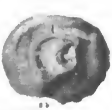
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PLATE VIII.

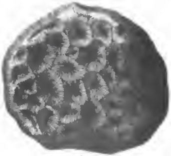
Fig. ... 1. LATIMÆANDRA OBCONICA, *Stol.*, p. 38; upper, side and lower views in natural size; 1*c*, a small portion of the upper surface enlarged; *E. of Parally, Ootatoor group.*

Figs. 2—3. LATIMÆANDRA GYRINA, *Stol.*, p. 38; 2, 2*a*, upper and lower views of a corallum in natural size; 3, a portion of another corallum, enlarged twice the natural size; *E. of Parally, Ootatoor group.*

Fig. ... 4. LATIMÆANDRA CRASSA, *Stol.*, p. 39; a portion of a corallum in natural size; *Odium, Ootatoor group.*

Fig. ... 5. THAMNASTREA HIEROGLYPHICA, *Stol.*, p. 41; a portion of a corallum in natural size, and a few calyces enlarged; *Kauray, Ootatoor group.*

Fig. ... 6. LATIMÆANDRA INTERRUPTA, *Stol.*, p. 39; 6, a portion of the corallum in natuarl size; 6*a*, a small portion of the surface enlarged; *Parally, Ootatoor group.*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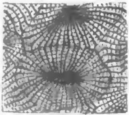
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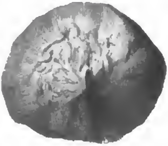
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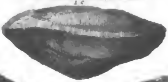
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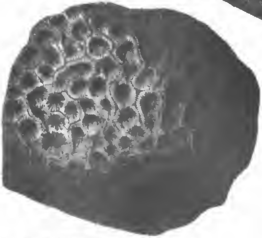
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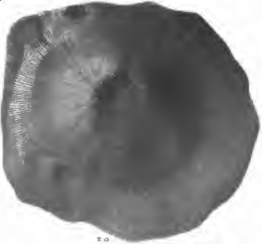
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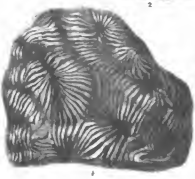
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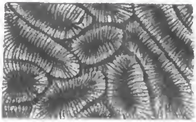
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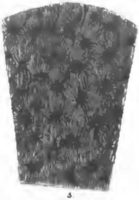
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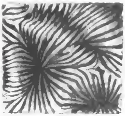
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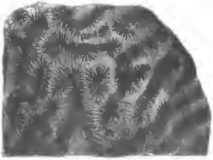
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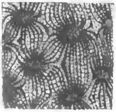
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PLATE IX.

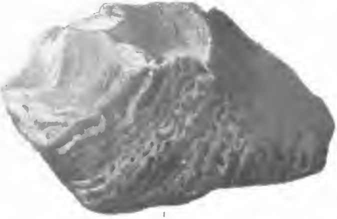
Fig. ... 1. LATIMÆANDRA [? MÆANDRASTREA] CONCENTRICA, *Reuss*, p. 40; 1, upper view of a corallum; 1*a*, a small portion of the original surface; 1*b*, a similar one of the polished surface, enlarged; *Odium, Ootatoor group.*

Figs. 2—3. THAMNASTREA BREVIPES, *Stol.*, p. 42; 2, 2*a*, 2*b*, upper, side and lower views, natural size; 2*c*, a small portion of the upper surface enlarged; 3 and 3*a*, side and upper views of another smaller corallum; *Ninnyoor, Arrialoor group.*

Fig. ... 4. THAMNASTREA CRASSA, *Stol.*, p. 43; 4, a small portion of the original surface; 4*a*, an enlarged portion of the same corallum; *Odium, Ootatoor group.*

Fig. ... 5. THAMNASTREA PULLATA, *Stol.*, p. 43; the corallum in natural size, and a small portion of the surface enlarged; *Parally, Ootatoor group.*

Fig. ... 6. THAMNASTREA INDUTA, *Stol.*; p. 44; polished view of the upper surface of a shortly pedicellated corallum; *Odium, Ootatoor group.*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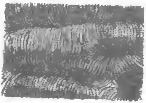
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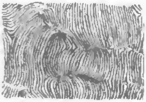
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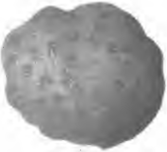
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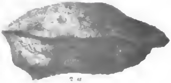
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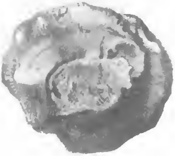
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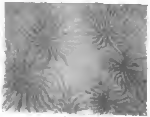
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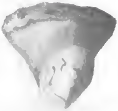

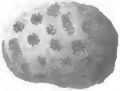
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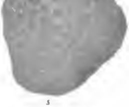
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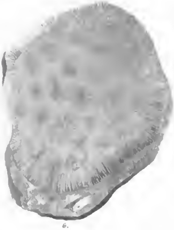
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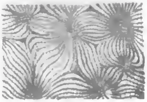
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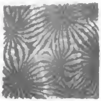
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PLATE X.

Fig. ... 1. Thamnastrea induta, *Stol.*, p. 44; 1 and 1 *a*, upper and side views of a corallum in natural size; 1*b*, a small portion of the polished surface enlarged; *Odium, Ootatoor group.*

Fig. ... 2. Dimorphastrea patellaris, *Stol.*, p. 45; similar views as of the last species; *E. of Poodoor, Ootatoor group.*

Fig. ... 3. Comoseris Oldhamiana, *Stol.*, p. 46; 3 and 3*a*, upper and lower views of the entire corallum in natural size; 3*b*, original surface, and 3*c*, polished surface, enlarged; *N. W. of Moraviatoor, Ootatoor group.*

Figs. 4—5. Cyclolites conoidea, *Stol.*, p. 48; three views of a smaller and of a larger specimen in natural size; *Valudayur, Arrialoor group.*

Figs. 6—9. Cyclolites fæcata, *Stol.*, p. 48; 6, 6*a*, 6*b*, three views of an almost perfect specimen; 7, upper view with a more weathered surface; 8*a*, section; 9, lower view of a smaller specimen; *Veraghoor, Arrialoor group.*

Figs. 10—12. Cyclolites filamentosa, *(Forbes)*, p. 49; 10, 10*a*, 10*b*, three views of a perfect specimen; 10*c*, a small portion of the surface enlarged; 11, horizontal section below the middle of the corallum; 12, a weathered vertical section, showing the thickness of the basal theca; *Valudayur, Arrialoor group.*

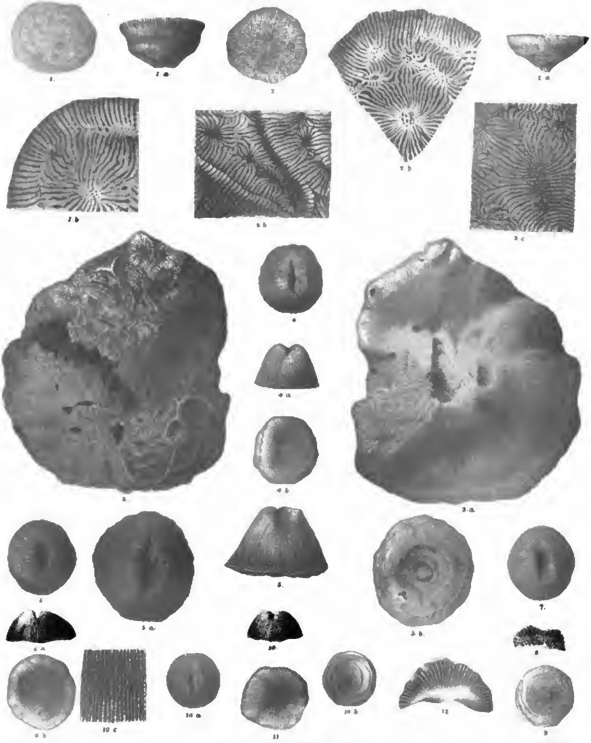

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PLATE XI.

Fig. ... 1. Thecoseris agaricina, *Stol.*, p. 47; upper and lower views of a corallum; *Odium, Ootatoor group.*

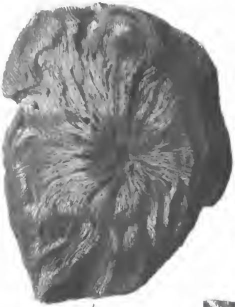
Fig. ... 2. Cyclolites orbiculus, *Stol.*, p. 49; 2, *2a*, *2b*, three views in natural size; *2c*, upper view enlarged; *Veraghoor, Arrialoor group.*

Figs. 3—7. Eupsammia varians, *Stol.*, p. 51; specimens of various sizes and shapes; *6a* and *7a* are polished sections; *Odium, Ootatoor group.*

Figs. 8—9. Eupsammia denotata, *Stol.*, p. 52; 8, *8a*, side view and polished section; 9, *9a*, vertical and horizontal section of another corallum; *Odium, Ootatoor group.*

Fig. ... 10. Coscinarea *conf.* mammillata, *Reuss*, p. 53; a small portion of the surface, enlarged seven diameters; *Odium, Ootatoor group.*

Fig. ... 11. Heliopora Edwardsana, *Stol.*, p. 53; 11, side view of the corallum in natural size; *11a*, a piece of polished, and *11b*, a similar one of the original, surface; *E. of Kauray, Ootatoor group.*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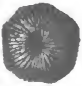
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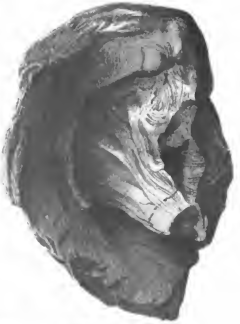
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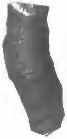
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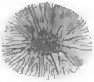
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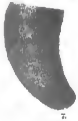
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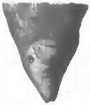
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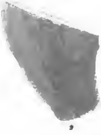
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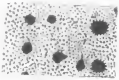
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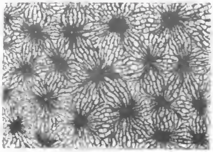
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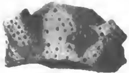
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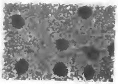
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PLATE XII.

Figs. 1—2. Siphonia piriformis, *Goldf.*, p. 60; 1, 1*a*, side and upper views of a nearly complete specimen; 2, vertical section of a broader and shorter specimen; *Moraviatoor, Ootatoor group.*

Figs. 3—5. Orbitoides Faujasi, *Defr.*, p. 61; 3, 3*a*, 3*b*, 3*c*, two views of a complete specimen in natural size and enlarged; 4, a section of another specimen; 5, horizontal section; *Ninnyoor, Arrialoor group.*

Fig. ... 6. Serpula filiformis, *Sow.*, p. 63; a portion of a calcareous sandstone showing the tubes in their original position; *Arrialoor, Arrialoor group.*

Figs. 7—8. Serpula *conf.* cordialis, *Schloth.*, p. 64; two different specimens; 7 is from *Arrialoor*, 8 from *Mulloor, Arrialoor group.*

Figs. 9—10. Serpula Ootacoodensis, *Stol.*, p. 64; 9 is from *Ootatoor*, 10 from *Odium, Ootatoor group.*

Fig. ... 11. Serpula? hamata, *Forbes*, p. 64; copy after Forbes; the dotted line indicates the probable correct outline, and 11*b* a section of the tube with the shell surface preserved; ?——— *? Ootatoor group.*

Fig. ... 12. Ditrupa? longissima, *Forbes*, p. 65; copy after Forbes; *Pondicherry, ? Arrialoor group.*

Figs. 13—14. Neocarcinus? p. 68; 13, fragmentary carapace, ? *Veraghoor*, ? *Trichinopoly group;* 14, copy after Forbes.

Fig. ... 15. Haploparia? a small imperfect portion of a hand; *Ootatoor, Ootatoor group.*

Fig. ... 16. Ptychodus latissimus, *Ag.*, p. 66; *Olapaudy, Arrialoor group.*

Fig. ... 17. Sphærodus rugulosus, *Eg.*, p. 66.

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Fig. 24. Otodus *conf.* semiplicatus, *Münst*; p. 67; *Kunnanore, Arrialoor group.*

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Fig. .. 38. Lamna complanata, *Eg.*, p. 69.

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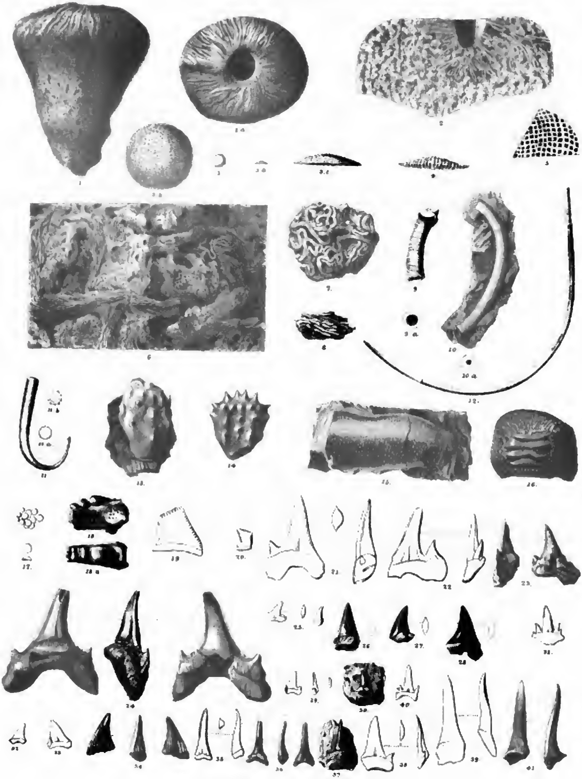
Fig. ... 40. Odontapsis oxyprion, *Eg.*, p. 69.

Fig. ... 41. Enchodus serratus, *Eg.*, p. 69.



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